Duke Energy South Bay LLC

316(b) Proposal for Information Collection for South Bay (San Diego) Power Plant

Submitted In Compliance with 316(b) Phase II Regulatory Requirements

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Submitted to:

Regional Water Quality Control Board
San Diego Region
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Prepared by:

TENERA Environmental
971 Dewing Ave., Suite 101, Lafayette, CA 94549
925.962.9769, FAX: 925.962.9758

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List of Acronyms

AFB	Aquatic Filter Barrier
Board	California Regional Water Quality Control Board, San Diego Region
BTA	Best Technology Available
CDS	Comprehensive Demonstration Study
CEC	California Energy Commission
CWIS	Cooling Water Intake Structure
CWP	Circulating Water Pump
E	Entrainment
EPA	Environmental Protection Agency
IM	Impingement Mortality
ISO	Independent System Operator
NPDES	National Pollutant Discharge Elimination System
OTC	Once Through Cooling
PIC	Proposal for Information Collection
QA/QC	Quality Assurance/Quality Control
SBPP	South Bay Power Plant
TIOP	Technology Installation and Operation Plan
TWS	Traveling Water Screen

Executive Summary

This Proposal for Information Collection (PIC) is submitted in compliance with the final 316(b) Phase II Rule (the Rule) for existing electric generating stations published in the Federal Register on July 9, 2004. The PIC provides the California Regional Water Control Board, San Diego Region (the Board) with Duke Energy's plans for:

- providing necessary biological information,
- evaluating alternative fish protection technologies,
- evaluating the Rule's compliance alternatives, and
- providing information on consultations with fish and wildlife agencies.

Due to its withdrawal of cooling water from San Diego Bay and having an overall capacity utilization rate exceeding 15%, South Bay Power Plant (SBPP) will be required to meet both the impingement mortality (IM) and entrainment (E) reduction standards of 80% to 95% and 60% to 90%, respectively. Updated impingement and entrainment monitoring studies at SBPP[1] were completed in 2004 at the request of the Board by a Water Code Section 13267 letter. In the letter, Board staff concluded that some of the results and conclusions from previous cooling water intake structure (CWIS) and thermal effects studies conducted in the 1980s needed to be updated because they did not reflect current plant operations or were not representative of existing conditions in south San Diego Bay. The results of the most recent studies were used in continuing the National Pollutant Discharge Elimination System (NPDES) permit renewal process for SBPP Permit Number CA0001368. Duke Energy plans to rely on those studies for developing the estimates for the IM&E Baseline Characterization as required by the Rule.

Duke Energy plans to evaluate the full range of compliance options offered by the Rule. Because significant modifications to the CWIS, such as constructing an offshore intake, have been judged impractical from a cost-benefit standpoint, Duke's preferred means to meet the Rule's entrainment performance standard for the SBPP is the retirement of the existing facility's steam generating units (Units 1-4).[2] Duke anticipates the possibility of retiring Units 1-4 at the end of Duke's lease to operate the Port of San Diego's SBPP facility in 2009. Notwithstanding,

[1] Duke Energy South Bay L.L.C. 2004. SBPP Cooling Water Effects on San Diego Bay: Volume II: Compliance with 316(b) of the Clean Water Act for the South Bay Power Plant.

[2] Duke Energy leases both the power generating facilities located on the site and the site property from the Port of San Diego under an operating agreement that is due to expire in 2009. At the present time there are no plans to continue the operation of the existing facilities or replace them with newer equipment. Therefore, the number of alternative intake technologies that might otherwise be considered feasible for the South Bay Power Plant are infeasible simply due to the fact that the time necessary to design, permit, and construct a number of the alternative technologies would extend beyond the life of the facility. The same remaining brief life of the facility would also make the amortization capital costs of other alternatives that might be implemented in the short term wholly disproportionate to the return of environmental benefits.

the facility's retirement, Duke will reanalyze previously submitted 316(b) information to fully evaluate compliance with performance standards for entrainment and impingement mortality by reduction of flow for Unit 4 (which operates at less than 15% capacity utilization rate), credit for reuse of once through cooling (OTC) water, improvements in fish return technology, and implementation of restoration measures, as might be required for full compliance. The use of selected technologies and site-specific standards will also be evaluated as discussed in Section 3.0 of this PIC. The primary technologies that will be evaluated include use of cylindrical narrow slot wedgewire screens and fine mesh traveling screens. This PIC also provides an updated schedule consistent with the Board's schedule adopted in the facility's renewed NPDES permit.

1.0 Introduction

EPA signed into regulation new requirements for existing electric power generating facilities for compliance with Section 316(b) of the Clean Water Act on July 9, 2004. These regulations became effective on September 7, 2004 and are based on numeric performance standards.[3] The Rule at 125.94(a)(1-5) provides facilities with five compliance alternatives as follows:

1. *The discharger may demonstrate that the flow from the power plant will be reduced to levels commensurate with a closed cycle recirculating system or that the maximum through-screen design intake velocity will be reduced to 0.5 ft/s or less.*

2. *The discharger may demonstrate that the existing design and construction technologies, operational measures, and/or restoration measures meet the performance standards specified in Section 125.94(b) of the rule and/or the restoration requirements specified in Section 125.94(c) of the rule.*

3. *The discharger may demonstrate it will install and properly operate and maintain, design and construction technologies, operational measures, and/or restoration measures that will, in combination with any existing design and construction technologies, operational measures, and/or restoration measures, meet the performance standards specified in paragraph (b) of this section and/or the restoration requirements in paragraph (c) of this section.*

4. *The discharger may demonstrate that it has installed, or will install, and properly operate and maintain an approved design and construction technology in accordance with Sections 125.99(a) or (b) or the rule.*

5. *The discharger may demonstrate that it has selected, installed, and is properly operating and maintaining, or will install and properly operate and maintain design and construction technologies, operational measures, and/or restoration measures that the Regional Board has determined to be the best technology available to minimize adverse environmental impact for the power plant (based on a site-specific, best technology available, cost analysis conducted in accordance with Section 125.94 (a)(5)(i) or (ii) of the rule).*

All facilities that use compliance alternatives 2, 3 and 4 are required to demonstrate a minimum reduction in impingement mortality of 80% (125.94(b)(1)). Facilities with a capacity factor that is greater than 15% that are located on oceans, estuaries, or the Great Lakes, or on rivers and have a design intake flow that exceeds more than 5% of the mean annual flow must also reduce entrainment by a minimum of 60% (125.94(b)(2)).

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[3] Performance standards are found at Federal Register, Vol. 69, 7/9/04, 125.94(b).

The Rule further requires that facilities using compliance alternatives 2, 3, and 5 prepare a Comprehensive Demonstration Study (CDS) as described at 125.95(b) of the Rule based on each of the seven components of the CDS (as appropriate) for the compliance alternative or alternatives selected. Facilities using Compliance Alternative 1 are not required to submit a CDS and those using Compliance Alternative 4 are only required to submit the Technology Installation and Operation Plan (TIOP) and Verification Monitoring Plan. All facilities that use compliance alternatives 2, 3 and 5 are required to prepare and submit a "Proposal for Information Collection" (PIC), the first component of the CDS. The Rule at 125.95(b)(1) requires that the PIC include:

1. *A description of the proposed and/or implemented technologies, operational measures, and restoration measures to be evaluated.*

2. *A list and description of any historical studies characterizing impingement mortality and entrainment (IM&E), and /or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed Study. If you propose to use existing data, you must demonstrate that the data are representative of current conditions and were collected using appropriate quality assurance/quality control procedures.*

3. *A summary of any past or ongoing consultations with relevant Federal, State, and Tribal fish and wildlife agencies and a copy of written comments received as a result of each consultation.*

4. *A sampling plan for any new studies you plan to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of IM&E at your site. The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods you propose must be appropriate for a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area (including the area of influence of the CWIS), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).*

The preamble to the Rule on Federal Register Page 41635 states that the PIC should provide other information, where available, to the NPDES permitting authority regarding plans for preparing the CDS such as how the facility plans to conduct a Benefits Valuation Study or gather additional data to support development of a Restoration Plan.

An important feature of the Rule is use of the calculation baseline. The calculation baseline is defined in the rule as follows:

Calculation baseline means an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody; and the baseline practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, including flow or velocity reductions, implemented in whole or in part for the purposes of reducing impingement mortality and entrainment. You may also choose to use the current level of impingement mortality and entrainment as the calculation baseline. The calculation baseline may be estimated using: historical impingement mortality and entrainment data from our facility or another facility with comparable design, operational, and environmental conditions; current biological data collected in the waterbody in the vicinity of your cooling water intake structure; or current impingement mortality and entrainment data collected at your facility. You may request that the calculation baseline be modified to be based on a location of the opening of the cooling water intake structure at a depth other than at or near the surface if you can demonstrate to the Director that the other depth would correspond to a higher baseline level of impingement mortality and/or entrainment.

This definition allows existing facilities with a variety of study options to take credit for facility features that deviate from the calculation baseline and provide the benefit of fish protection. Facilities can also simply develop the baseline by documenting their existing levels of IM&E.

2.0 Description of South Bay Power Plant

2.1 Location and Physical Description of Cooling Water Intake Structure and Cooling System

The South Bay Power Plant (SBPP) is located in Chula Vista, California on the southeastern margin of San Diego Bay (**Figure 2-1**). The plant uses the waters of San Diego Bay for once-through cooling of its four steam generating units. Each unit's cooling water is supplied by two circulating water pumps (CWPs). Individual pump output varies between units, ranging from 148 m^3/min to 259 m^3/min (39,000 gallons per minute [gpm] to 68,400 gpm) based on the manufacturer's pump performance estimates. The quantity of cooling water circulated through the plant is dependent upon the number of pumps in operation (**Table 2-1**). With all pumps in operation, the cooling water flow through the plant is 1,580 m^3/min (417,400 gpm) or 2,275,000 m^3/day (601.1 million gallons per day [mgd]).

Table 2-1. Generating capacity and cooling water flows of the South Bay Power Plant.

Unit	Gross Generation (MWe)	Flow from two CWP/unit	
		(m^3/min)	(gpm)
1	152	295	78,000
2	156	295	78,000
3	183	472	124,600
4	232	518	136,800
Total	**723**	**1,580**	**417,400**

Cooling water is withdrawn from San Diego Bay via an intake channel that connects the SBPP with the southeast corner of the bay. The intake channel is about 180 m (600 ft) in length and has a bottom width of about 60 m (200 ft) at its widest point and then tapers to 15 m (50 ft) near the Unit 4 screenhouse. The maximum depth of the channel is approximately –5.4 m (–17.7 ft) mean lower low water (MLLW). The channel was dredged and diked during plant construction in the early 1960s. The dredged material was placed behind the channel dikes to form part of the Chula Vista Wildlife Island between the intake and discharge channels. Variations in water level attributable to the tides, range from a low of –0.7 m (–2.3 ft) to a high of +2.5 m (+8.2 ft) MLLW.

The cooling water intakes utilized by the SBPP consist of three separate cooling water intake structures (CWIS) for its four units. Units 1 and 2 share a single CWIS while Units 3 and 4 have their own individual CWISs. A floating boom has been deployed across the intake channel upstream of the screenhouses to stop floating debris and prevent it from entering the screenhouses. In the past, the plant has deployed a 1-inch mesh debris net across the channel during periods of high eelgrass and debris loading. The net was routinely deployed during the summer months from 1982 through 1986, but is now only used during periods of extraordinarily high debris influxes. As shown in **Figures 2-2** and **2-3**, water flow within the intake channel first approaches the screenhouse serving Units 1 and 2. The Unit 3 screenhouse is located an additional 40 m (131 ft) downstream, and the Unit 4 screenhouse another 28 m (92 ft) away, near the head of the channel.

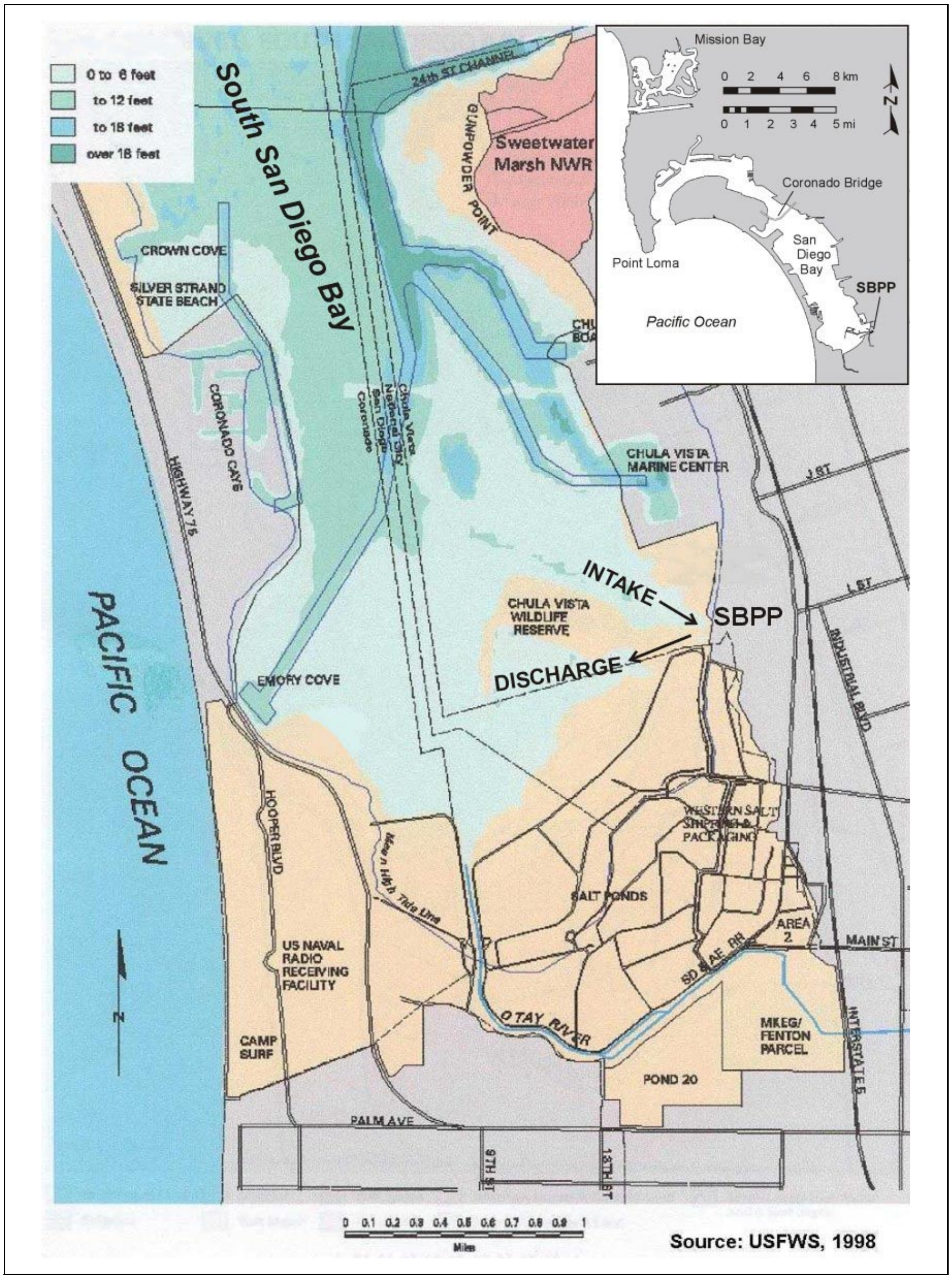

Figure 2-1. Location of South Bay Power Plant in south San Diego Bay.

Cooling water enters the screenhouses through stationary trash racks. The racks consist of vertical steel bars on 89-mm (3.5-in) centers with 76 mm (3.0 in) spacing between bars. The racks prevent larger organisms from entering the system and screen out any large debris that could damage the traveling water screens and CWPs located behind the racks. Each screenhouse is equipped with one traveling water screen (TWS) for each CWP. These are vertical "thru flow" TWSs. Water passes through vertical, ascending, rectangular trays or frames that support panels of stainless steel screen. Screen mesh size is either 9 mm (3/8 in) square or a 3 mm by 13 mm (1/8 in by ½ in) rectangle depending on the TWS. Debris is impinged upon the screen mesh and carried upward, out of the water, with the ascending panels. As each panel reaches the top of its circuit through the TWS, debris is removed from the screen by high-pressure water spray. The panel then descends the backside of the TWS, completing its circuit. Debris washed from the screens by the water spray enters a trough that flows to the discharge basin near the point of discharge for Units 1 and 2. The screens are automatically placed in operation when the build up of debris causes the pressure differential across the screen to reach a preset threshold.

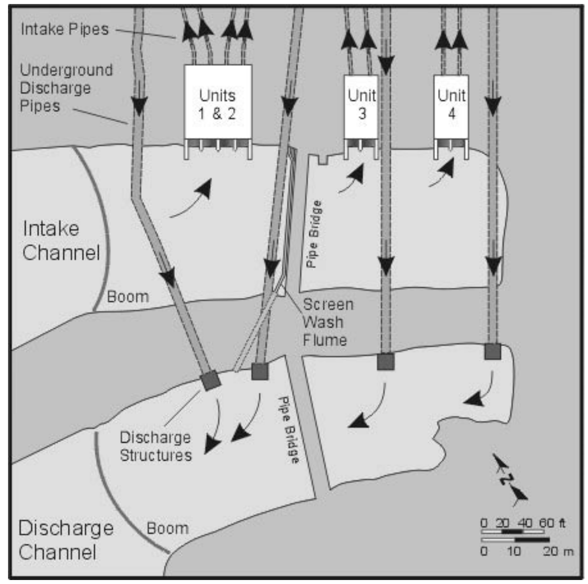

Figure 2-2. Diagram of SBPP circulating water intake and discharge structures.

Water approach velocity at the TWS was calculated based on the cross sectional area of the submerged portion of the screens at varying tidal heights, screen cross-sectional area, and CWP performance specifications. Assuming clean traveling screens with no debris accumulation, the approach velocity at the Unit 1 and Unit 2 TWS was calculated at 0.4 feet per second (fps) (0.12 meters per second (mps)) at high tide (+5.7 ft Mean Sea Level (MSL)), and

Figure 2-3. Aerial view of SBPP intake and discharge bays.

0.9 fps (0.27 mps) at low tide (-5.0 ft MSL).[4] Water approach velocity at the Unit 3 and Unit 4 TWS was calculated at 0.7 fps (0.21 mps) at high tide, and 1.4 fps (0.43 mps) and 1.5 fps (0.46 mps) for each unit respectively, at low tide. Based on these previously calculated approach velocities and assuming a 50% loss of clear space due to the traveling screen frames and mesh, the through-screen velocities would be expected to exceed the Rule's performance standard of 0.5 fps.

Duke will use the results of its recently completed impingement studies characterizing the effects of the non-conforming intake velocities (>0.5 fps) to evaluate the feasibility and potential cost-benefits of various intake technologies to reduce impingement mortality. The PIC proposes studies that will investigate the benefits of the existing fish return system, and assess various technologies and operations to improve its effectiveness to reduce impingement mortality.[5]

Directly behind the TWS are the circulating water pumps. The SBPP discharge (and intake) flow data were derived from the plant operator's daily logs. The logs specify which pumps were in operation for each hour of the day and usually, but not always, when a pump was started or stopped. For NPDES reporting purposes, and for the recent 316(b) report, pump operation was rounded to the nearest hour (e.g., if a pump was shut down ten minutes into the hour, it was considered "off" for the entire hour; if a pump was shut down 31 minutes after the hour, it was considered "on" for the entire hour). Pump output is based on manufacturer's pump curves. The volume of cooling water utilized by SBPP is dependent upon the number of CWPs that are in operation at any given time. Although the pumps are designed to operate at a constant motor speed and discharge volume, actual pump performance can be affected by changes in tide height, occlusion of the cooling water conduits by biofouling, and clogging of the condenser tubes by biofouling organisms or debris. Maximum volume with all eight pumps in continuous operation is 2,275,200 m^3/d (601.1 mgd). Daily average flow for the period from December 1, 1998 through September 30, 2003 ranged from 425,056 m^3/d (112.3 mgd), which represented the equivalent of both of the smaller Unit 1 or Unit 2 CWPs operating for 24 hours, to 2,275,200 m^3/d (601.1 mgd), which represented the continuous operation of all eight pumps (**Figure 2-4**). Maximum discharge volume occurred much more frequently between December 1998 and the end of 2000. Since that time, a decline in demand for electricity from SBPP and the consequent reduction in generation have reduced the frequency of full flow operation periods. Unit 4 in particular saw limited use in 2002 and 2003. During 2003, SBPP operated all eight CWPs for a period of about 24 hours per week to accommodate the impingement sampling conducted as part of the 316(b) studies described in this report. As a result, the cooling water volumes for this period are more variable than those from 1999–2002.

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[4] San Diego Gas & Electric Company (SDG&E). 1980. South Bay Power Plant Cooling Water Intake System Demonstration Summary. Prepared for California Regional Water Quality Control Board San Diego Region, San Diego CA.

[5] Ibid.

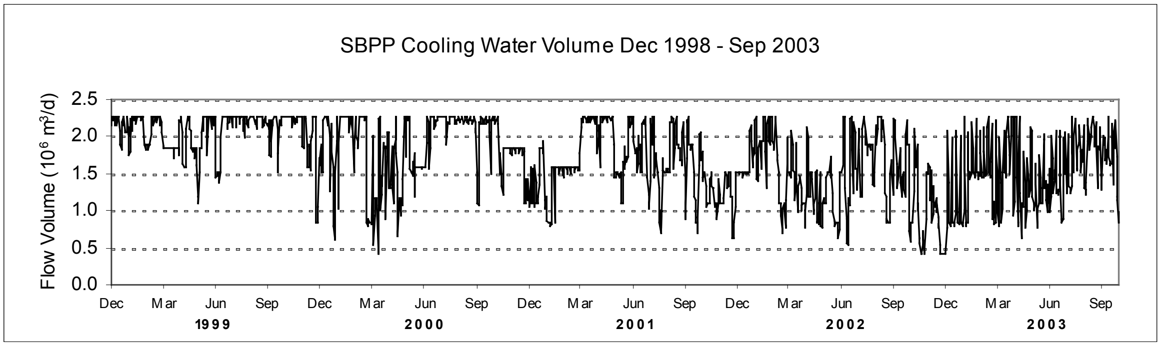

Figure 2-4. SBPP daily average cooling water flow from December 1, 1998 through September 30, 2003.

Cooling water from the Units 1 and 2 CWPs exits the screenhouse via four 122 cm (48 in) diameter conduits that carry the flow approximately 61 m (200 ft) to the units' condensers. Intake conduits for Units 3 and 4 (one for each CWP) are 152 cm (60 in) in diameter, and also 61 m long. At each of the condensers, the cooling water is dispersed through several thousand thin walled condenser tubes. Units 1, 2, and 3 have dual pass condensers that direct the cooling water through the condenser twice. Unit 4's condenser is a single pass design. The Unit 1 condenser tubes are constructed of AL-6X, a stainless steel alloy, while the other condensers are copper-nickel tubes. Exhaust steam, exiting the plant's turbines, passes over the exterior of the tubes and is condensed by the cooling water flowing within the tubes. The resulting condensate is pumped back to the plant's boilers as part of the continuing steam cycle, and the cooling water exits the condenser as heated effluent. The change in cooling water temperature, or delta T, that occurs during passage through the condenser will vary with plant load and can also be affected, to a lesser degree, by condenser tube fouling, tube blockage (caused by debris), and fluctuations in cooling water flow caused by tidal shifts or degradation of CWP performance. Detailed information regarding the discharge system is found in *Volume 1: South Bay Power Plant 316(a) Thermal Discharge Assessment Report.*

SBPP uses periodic chlorine injection to prevent or inhibit microfouling on the heat transfer surfaces of its condensers and ancillary heat exchangers. The discharge limits for total residual chlorine at the point of discharge are dependent upon the number of power generating units that are in operation. The allowable discharge levels decrease as more circulating water pumps are operated due to the increase in flow volume added to the discharge. If the circulating water pumps for one unit are in operation, the allowable discharge is 144 parts per billion (ppb) of total residual chlorine (TRC). If 2, 3, or 4 units are in operation, the allowable discharge concentration is reduced to 111 ppb, 95 ppb, or 85 ppb TRC, respectively.

2.2 Applicable Performance Standards

SBPP withdraws water from a bay and is therefore subject to both the impingement mortality and entrainment reduction performance standards. If the plant's capacity utilization, based on five years of operating data, is 15% or less, it would only be subject to the impingement performance standard. The Rule states "the capacity utilization rate may be calculated separately for each intake structure, based on the capacity utilization of the units it services." As discussed in Section 2.1, SBPP has three separate CWISs. The capacity utilization for each unit from 2000 through 2004 is shown in **Table 2-1**. Based on this operating period, Units 1, 2, and 3 all exceeded a 15% capacity utilization. However, Unit 4's capacity utilization was 12% in 2004, and has not exceeded 15% since 2000. Therefore, the entrainment standard would not apply to Unit 4. When Duke Energy submits the CDS in November 2007 applicable standards will be based on the period 2002 through 2006. At this point Duke Energy does not expect capacity utilization to change significantly for these units from that shown in **Table 2-1**.

The Rule allows facilities to take credit for deviations from the calculation baseline if it can be demonstrated that these deviations provide the benefit of fish protection to impingeable-sized organisms. SBPP does have a number of deviations from the baseline that include:

- Use of an intake canal rather than a shoreline intake structure,
- Use of a fish and debris return system,
- Use of 1/8 in by 1/2 in mesh traveling screens on Units 1 and 2 instead of 3/8-in mesh screens, and
- Some amount of cooling water is re-circulated due to the location of SBPP at the head of San Diego Bay.

Section 3.1 of PIC discusses Duke's plans to take credit for the appropriate deviations under the calculation baseline.

Table 2-1. Capacity utilization by unit at SBPP from 2000–2004.

	Plant Total	Unit 1	Unit 2	Unit 3	Unit 4
2000	36.1	57.3	38.3	40.4	17.1
2001	32.7	48.8	46.5	37.0	9.4
2002	20.5	33.1	33.9	19.5	4.0
2003	21.9	31.8	35.5	26.7	2.4
2004	31.4	40.5	46.4	35.6	12.0

3.0 Compliance Alternatives to be Evaluated

Duke Energy intends to evaluate the full range of compliance alternatives and options available in the final Rule for potential use in the Comprehensive Demonstration Study (CDS). However, Duke also has certain preferences for compliance because some options are considered to be more feasible, cost-effective, and environmentally beneficial than others. This section of the PIC provides a description of specific alternatives and options that will be evaluated for compliance. It also indicates Duke's preferred compliance alternatives and options based on currently available information, as well as some of the issues currently identified with these alternatives and options.

3.1 Use of Compliance Alternative 2 for Existing Fish Protection Design and Operational Measures

As discussed in Section 2.2, SBPP currently employs design and operational features that have the potential to provide the benefit of fish protection. Specifically there are two such features that Duke plans to evaluate and estimate a credit toward compliance with the standard if appropriate. These features, the fish collection and return system and re-circulation of cooling water, are discussed below.

3.1.1 Fish Collection and Return System

SBPP uses a fish and debris collection and return system that collects impinged fishes and returns them to the source waterbody. Unlike entrainment, the impingement performance standard is based on impingement mortality rather than the total number of fishes impinged. During the course of the rulemaking, EPA determined there were many facilities such as SBPP that incorporated fish return systems into their design. Numerous studies have evaluated these systems and determined that survival of fishes returned could be significant. While the calculation baseline assumes 100% mortality (i.e., the baseline assumes no fish return system), facilities incorporating this design feature can take credit against the baseline. SBPP has an additional design feature, use of 1/8 in x 1/2 in mesh for Units 1&2, which has the potential to provide not only a benefit to impingeable-sized fish but to entrainable-sized fish as well. The Rule's calculation baseline assumes 3/8-in mesh and the smaller sized mesh on the Units 1&2 intake allows collection and return of fish that would normally be entrained through the baseline's 3/8-in mesh screens. SBPP plans to initiate studies as discussed in Section 4.3 to quantify survival rates that include consideration of screen rotation frequency, and the current fish return location in the discharge canal. Based on these studies, Duke may consider possible enhancements to the fish return system to increase survival rates under Compliance Alternative 3.

3.1.2 Recirculation of Cooling Water

SBPP is located at the head of San Diego Bay (**Figure 2-1**). Because of the reduced natural circulation in this part of the Bay, in combination with the location of the cooling water discharge south of the cooling water intake canal, there is some level of re-circulation of discharge water into the intake. The Rule requires facilities to assume that all entrained fish and shellfish experience 100% mortality. The Rule states "Facilities that recirculate a portion of their flow, but do not reduce flow sufficiently to satisfy the compliance option in §125.94(a)(1)(i) may take into account the reduction in impingement mortality and entrainment associated with the reduction in flow when determining the net reduction associated with existing design and construction technologies and/or operational measures." A two-phased approach will be used for this analysis. The first phase will be to use existing models and information to determine the potential level of re-circulation. Based on results of this analysis, additional studies may be proposed as appropriate to estimate the potential re-circulation credit if deemed to be significant.

3.2 Use of Compliance Alternative 1 by Reducing Flows Commensurate to Closed Cycle Cooling

Duke Energy leases both the site property and the power generating facilities located on the site from the Port of San Diego under a lease agreement that expires in November 2009. The current agreement includes a stipulation to re-evaluate the "Reliability Must Run" (RMR) status of SBPP. If, as a result of the re-evaluation, the plant is considered by the California Independent System Operator (ISO) to be a RMR facility, the lease will continue in effect until that status is terminated. If the ISO determines that the facility is no longer a RMR plant, Duke is obligated to demolish the plant unless the Port waives this requirement. At this time, Duke Energy believes it is unlikely that it will continue to operate the existing plant after November 2009, and any operating scenarios after that date are highly speculative, both in terms of the identity of the operator and the rate at which the plant would operate, if at all.

In the evaluation of CWIS alternatives, project costs are amortized from the point of project financing approval. Should the plant continue to operate after that time, the NPDES permit will need to be renewed again and the CWIS alternatives can be re-evaluated at that time.

As a result of the agreement and re-evaluation, it is highly likely that the plant may be retired from service.[6] In this event it will cease to be a Phase II facility and flows will have been

[6] Duke Energy leases both the power generating facilities located on the site and the site property from the Port of San Diego under an operating agreement that is due to expire in 2009. At the present time there are no plans to continue the operation of the existing facilities or replace them with newer equipment. Therefore, the number of alternative intake technologies that might otherwise be considered feasible for the South Bay Power Plant are infeasible simply due to the fact that the time necessary to design, permit, and construct a number of the alternative technologies would extend beyond the life of the facility. The same remaining brief life of the

reduced to even less than the equivalent for closed cycle cooling under Compliance Alternative 1. If the final decision is made to retire the facility, the requirements of 316(b) will no longer apply. It is emphasized that at this time no final decision has yet been made. If a final decision is made prior to November 2007 the San Diego Board will be informed in writing and no CDS will be submitted. Until a decision regarding retirement of the plant is made, Duke plans to continue through the CDS information collection and alternatives analysis in order to ensure compliance with the NPDES permit and the 316(b) Rule.

3.3 Use of Restoration under Compliance Alternative 3

The EPA final Phase II Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available (BTA) on a site-specific basis. The basic philosophy of restoration is mitigation of fish and shellfish losses at a CWIS by either direct supplementation (stocking) of a "species of concern" potentially impacted by the CWIS, or provision, protection, and restoration of habitat that "produces" fish and shellfish and thereby replaces those lost due to IM&E. In the event that SBPP is not decommissioned, Duke views restoration as a preferred method for meeting the entrainment reduction performance standard to make up any shortfall in meeting IM&E standards after taking credit for existing fish protection measures (see Section 3.1). However, it is also recognized that there is some risk this option may not be available.[7]

Appendix A provides a summary of the kinds of restoration measures that will be considered. Project examples are listed for the following reasons: (1) their 316(b) application history by other power companies, (2) a known interest in the local area based on an internet review of state programs, and (3) because design and implementation information is readily available. The basic categories of considered projects are as follows:

- Habitat Protection or Creation Program,
- Fish Stocking, and
- Waterbody Restoration.

Other types of projects may be identified in discussions with appropriate state and federal agencies.

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facility would also make the amortization capital costs of other alternatives that might be implemented in the short term wholly disproportionate to the return of environmental benefits.

[7] Duke is aware that use of restoration is currently the subject of Phase II Rule litigation. The Second Circuit Court ruled that restoration could not be used for compliance with the 316(b) Phase I Rule. Based on the Phase I litigation decision, EPA added significant text to the Phase II Rule to support its use in Phase II. Duke plans to initially limit evaluation of this compliance option to discussions with the Board and appropriate state and federal fish and wildlife agencies to identify potential projects of interest and methods for scaling and verification monitoring related to projects of interest.

Duke plans to discuss these ideas and consider other restoration alternatives that may be applicable and will also consider working with other companies with local Phase II facilities to develop joint projects. As part of the requirement for use of restoration, Duke plans to fully evaluate available technologies and/or operational measures to demonstrate that existing and supplemental restoration is more feasible, cost-effective, or environmentally desirable than use of meeting performance standards through use of technologies and/or operational measures (see below in Section 3.4). The analysis of IM&E data described in Appendix B will be used in determining the amount of restoration necessary to provide a minimum benefit equivalent to at least an 80% IM reduction and 60% E reduction as required by the Rule.

3.4 Use of Technologies or Operational Measures under Compliance Alternatives 3 and 4

Duke plans to evaluate a variety of technologies and operational measures for compliance. Generally the costs of technologies required for compliance with the entrainment performance standard are significantly more than those required for compliance with the impingement reduction performance standard, as outlined in the facility's 2004 316(b) Assessment.[8] Although SBPP will consider intake modifications to meet the IM reduction performance standard independently, Duke plans to focus mainly on the evaluation of technologies and operational measures that reduce both entrainment and impingement mortality. A recent review of fish protection technologies and operational measures was conducted as part of the SBPP 316(b) assessment.[9] Most of these alternatives were determined to be either cost-prohibitive or infeasible.

This section includes a review and evaluation of alternative cooling water system technologies to achieve compliance with 316(b) Phase II performance standards that require reductions in entrainment and impingement mortality. As was the case in the recently completed 316(b) assessment of intake alternatives,[10] it must be anticipated that very few technology alternatives will be cost effective especially considering that there may be few remaining years of plant operation. However, Duke plans to look closely again at the results of the analysis to identify cost-effective alternatives that would comply with the Phase II requirement to reduce entrainment or impingement mortality over the years remaining in their operation of the existing SBPP facility. Our analysis of alternatives focuses on those that were the focus of the Phase II Rule or that may otherwise cost-effectively reduce entrainment or impingement mortality.

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[8] Duke Energy South Bay L.L.C. 2004. SBPP Cooling Water Effects on San Diego Bay: Volume II: Compliance with 316(b) of the Clean Water Act for the South Bay Power Plant. *Section 6.0: Technological, Design and Operational Alternatives to Minimize Adverse Environmental Impacts.*

[9] Ibid.

[10] Ibid.

3.4.1 Design Options to Reduce Entrainment and Impingement Mortality

3.4.1.1 Previous Fish Protection Alternatives Analysis for SBPP

There are several types of physical barrier screen technologies that have either been proposed or utilized for various water intake systems to reduce entrainment and impingement.

Adjustable Vertical Barriers – This technology is used to redirect intake flows to reduce entrainment rates by selecting a level of the water column for withdrawal that has relatively lower concentrations of larvae or other organisms. There is no clear evidence that an adjustable vertical barrier could reduce entrainment rates because the concentrations of larvae in the shallow area of the intake are relatively uniform throughout the water column. Therefore, the adjustable vertical barrier alternative was eliminated from additional consideration of intake alternatives.

Stationary Screens – Passive stationary screens are generally used at facilities that have very small debris loads and are not subject to fouling. Because SBPP meets neither of these criteria, stationary screens are not considered feasible for use at this site.

Horizontal Traveling Screens – These screens combine elements of both diversion and collection devices. Years of design, research, and development efforts at two sites have demonstrated its lack of operational reliability.[11]

Rotary Drum Screens – Rotary drum screens are often considered as a technology for protecting fishes in freshwater environments, but they have never been used in a marine environment. A constant water elevation is required for effective drum screen operation. This intake technology would be infeasible in the tidally-influenced waters of San Diego Bay.

Behavioral Devices – Use of technologies based on light and sound have been evaluated due to their low cost for meeting the impingement performance standard. Previous studies have indicated that performance tends to be species specific and in some cases while found to be initially effective, performance declined over time due to fish acclimation to these devices. Due to some improvements such devices are currently being re-evaluated and Duke plans to monitor results of these studies to assess any potential application at SBPP.

3.4.1.2 Recent Technology Evaluation

Thirteen different physical barrier screen technologies to reduce entrainment and impingement were also evaluated in the previous 316(b) assessment, and of these, four of the technologies were determined to be proven and available. The screening technologies that were evaluated

[11] EPRI. 1999. Fish Protection at Cooling Water Intakes. EPRI Report No. TR-114013.

included vertical traveling screens, narrow-slot cylindrical wedgewire screens, and barrier nets. For purposes of this PIC, the following technologies highlighted in the Rule will be evaluated for compliance.

Fine-mesh Vertical Traveling Screens with Improved Fish Return System

Fine-mesh traveling screens are screens with mesh openings appropriate to reduce entrainment of organisms (i.e., typically 0.5–1.0 mm). An example of a fine-mesh traveling screen is shown in **Figure 3-1**. Fine mesh traveling water screens have been installed at a few large-scale steam electric cooling intakes. This technology is based on collecting entrainable life stages on the fine-mesh traveling screen panels, rinsing them into a fish return system for transport to the source waterbody in a location designed to minimize risk of re-entrainment. The cooling water approach velocity is an important factor that can affect performance. Normally these systems are designed to have an approach velocity that does not exceed 0.5 fps. Approach velocity can be significantly reduced by increasing the number of screens and increasing the intake opening size.

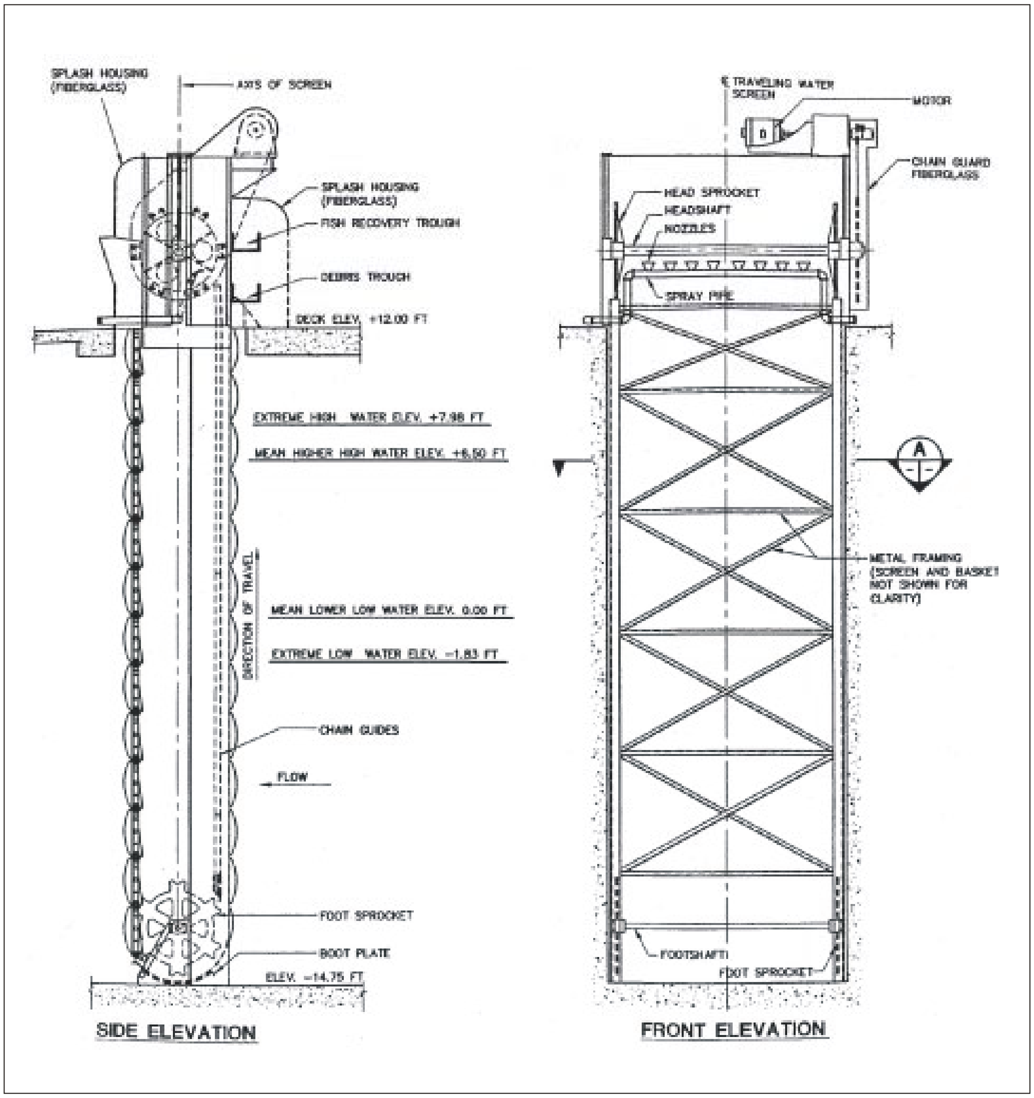

Figure 3-1. Example of fine-mesh vertical traveling screen system.

This alternative considers replacing the existing vertical traveling screens with new fine mesh (5/32-in) traveling screens, adding 15–30% additional cross–sectional screen area[12] to Units 1 & 2, and Units 3 & 4 CWISs, and improving the existing fish return system. Due to the higher velocities that occur during low water conditions pilot studies may be required to document adequate survival rates in order to determine if additional screens would need to be installed to meet the performance standard. The total number of traveling screens must increase in order to ensure that the through-screen velocity through the proposed smaller-sized mesh remains the same as currently experienced with the larger mesh screens. It may, however, be possible to simply replace the existing screens with fine-mesh screens.

[12] Typical range in open area loss in changing from 3/8” to 5/32” mesh screen material, as estimated by major traveling screen supplier.

The screen design would also include a primary low-pressure seawater spray system designed to gently rinse the fish and shellfish from the screens into the fish return system for transport to San Diego Bay. The system would be designed to operate continuously to return impinged organisms to the bay quickly and in good condition. The improved spray wash system will increase the efficiency of the overall removal of debris from the screen surface and intake well, reducing the potential for organism entanglement and maintaining low screen approach velocities. Reductions in the amount of debris immediately in front of the intake will lower the potential for entanglement and impingement of organisms such as fishes, crabs, and shrimps. Lower screen approach velocities are also expected to reduce the potential for impingement of weak or entangled organisms by reducing the amount of energy needed by these organisms to move away from the intake facility.

Narrow-Slot Cylindrical Wedgewire Screens

A schematic of the narrow-slot cylindrical wedgewire screen technology is shown in **Figure 3-2**. This technology is designed to work by using a low through-screen velocity relative to the ambient water current velocity. Protection of entrainable organisms is a function of the sweeping velocity of the water current past the screens relative to the through-screen velocity. Wedgewire screens are typically designed to meet the entrainment standard by using 0.5 mm slots. The cost of this technology is a function of slot size, since a smaller slot size requires use of more or larger screens to filter the same volume of cooling water. In addition, the industry standard design for wedgewire screens is a maximum through-slot velocity of 0.5 fps, which provides compliance with the impingement mortality performance standard under Compliance Alternative 1.

There are a number of concerns related to use of this technology for SBPP. The first is that the existing current velocity at the south end of San Diego Bay may not be adequate to generate the sweeping velocity necessary for the technology to be effective for entrainment. A second concern is that while these screens have been deployed at a number of freshwater facilities, they have not yet been deployed in marine environments such as San Diego Bay. The high biofouling environment and large tidal volume fluctuations present in San Diego Bay may preclude use of this technology at the facility. Currently narrow-slot cylindrical wedgewire screening systems are designed with a compressed air blast system to remove any accumulation of debris or fouling organisms. However in a marine environment, biofouling will also take place on the piping behind the screen and use of a method to control this fouling will be required. It may be necessary to conduct pilot studies to address these issues and verify feasibility and performance.

Figure 3-2. Example of narrow-slot wedgewire screens.

Barrier Nets

A fish net barrier is a mesh curtain installed in the waterbody in front of a CWIS. This technology is generally used to protect impingeable organisms by reducing velocity. All flow to the intake passes through the net so all aquatic life forms of a certain size are blocked from entering the intake. The net barrier is sized large enough to have very low approach and through net velocities of 0.1 ft/s or less to preclude impingement of juvenile fishes with limited swimming ability. In fact, the net could be designed to reduce the through-net velocity so as not to exceed 0.5 fps in which case this technology could be used under Compliance Alterative 1 and evaluated under Compliance Alternative 3. Barrier nets have been used in marine and estuarine environments. Use of barrier nets in these environments is more labor intensive than in freshwater environments since the nets may have to be changed frequently to control biofouling. Barrier nets have been effective in reducing impingement rates at several power plants that have long intake canals leading to the circulating water pumps. While barrier nets are generally designed for impingeable-sized fish and shellfish, nets can be designed with mesh sizes smaller than 3/8 in that would also provide some level of entrainment protection. However, it would not be feasible for a barrier net to protect smaller eggs and larvae.

The tidal current speeds, moderate debris loads, and wide variety in the size of organisms found at the SBPP site do not provide ideal conditions for a barrier net application.

Given the proper hydraulic conditions (primarily low velocity) and located in areas without heavy debris loading, barrier nets have been effective in preventing fishes from entering water intake canals. Several barrier nets located in the Midwestern U.S. have been studied.[13] At the Ludington Pumped Storage Plant on Lake Michigan, a 2.5-mile-long barrier net set around the intake jetties successfully reduced the impingement of all the fish species found in the vicinity of

[13] Michaud, D. T. and E. P. Taft. 1999. Recent Evaluation of Physical and Behavioral Barriers for Reducing Fish Entrainment at Hydroelectric Projects in the Upper Midwest. Proceeding of the EPRI/DOE Power Generation Impacts on Aquatic Resources Conference, Atlanta, GA (April 1999).

the intake.[14] The net was first deployed in 1989, and the original design was modified to be 96% effective for four species (yellow perch, rainbow smelt, alewife, and chub).

The Chalk Point Station on the Patuxent River used a two-barrier net system located at the mouth of the intake canal.[15] The outermost net (1.25-in stretch mesh) trapped most of the debris and jellyfish, while a finer mesh (0.75-in stretch mesh) inner net prevented impingement of smaller marine organisms (**Figure 3-3**). Modifications of the original system increased its effectiveness and achieved an 84% reduction in impingement of crabs. This net is located in a relatively high fouling environment and during the summer the net must be changed twice per week.

Fish Diversion, Collection, and Conveyance System Alternatives

The uses of fish diversion, collection, and conveyance systems are limited to reducing entrapment and impingement of juvenile and adult fishes, and have no effect on entrainment of eggs, larvae, and other early life stages of fishes. Fish diversion and collection systems such as louvers, angled screens, and modified traveling screens are only of benefit when they are installed and operated in concert with an effective fish return conveyance system.

A louver diversion system consists of an array of evenly spaced, vertical slats (venetian blind concept) aligned across an entry channel at a specified angle leading to a fish bypass. The design of the diversion system is based on the approach flow velocity and swimming speed of fish. The concept behind the system is that it will create a stimulus in the water to divert the fish to a safer area. The effectiveness of the system is based on species characteristics, life stage, and site specifics. Louvers generally are not considered acceptable by most environmental regulatory agencies in the country because they have been less effective compared to other fish protection systems. The louver system has been applied though to riverine environments with migratory species. Since louver arrays are necessarily set at an angle to the flow, they require a length of an intake channel or canal to work effectively. They are not applied to shoreline intake locations, but have been applied to onshore intake screen wells used in conjunction with offshore submerged intakes which entrap fish.

The angled screen design is composed of a series of vertical traveling screens arranged strategically at a certain angle to maximize fish/marine animal diversion leading to a primary bypass line. The organisms captured in the primary bypass line will typically be led to a secondary bypass line, holding tank, or released back to the natural habitat. Most of these screen installations or applications have been to protect young salmonids. Angled screens have been studied for possible use at CWIS to protect a variety of fishes in freshwater, riverine, estuarine,

[14] Reider, R. H., D. D. Johnson, P. B. Latvaitis, J. A. Gulvas, and E. R. Guilfoos. 1997. Operation and Maintenance of the Ludington Pumped Storage Project Barrier Net. *In:* Fish Passage Workshop, Milwaukee, WI, May 6-8, 1997.

[15] Loos, J. L. 1986. Evaluation of Benefits to PEPCO of Improvements in the Barrier Net and Intake Screens at Chalk Point Station Between 1984 and 1985. Prepared for Environmental Affairs Group Water and Land Use Department, Potomac Electric Power Company, Washington, D. C.

and marine environments. They also have been used in hydroelectric and irrigation intake facilities. Through the combined studies gained from those experiences, the angled screen system can be very effective in diverting fishes to the bypass line if given the proper physical and hydraulic conditions. Further consideration of angled screen systems for diverting and aiding in the collection of fishes at the SBPP CWIS, with total installed costs, would require extensive engineering feasibility and biological evaluations.

A fish return conveyance system would be required with any of the previously discussed fish diversion and collection systems. There are two basic types of conveyance systems for the return of entrapped or impinged organisms and debris to the waterbody, one using a trash pump to transport material away from the intake and one using gravity flow. The existing fish return system at SBPP could be improved by enclosing the return trough to prevent bird predation and extending the terminus of the trough into deeper water.

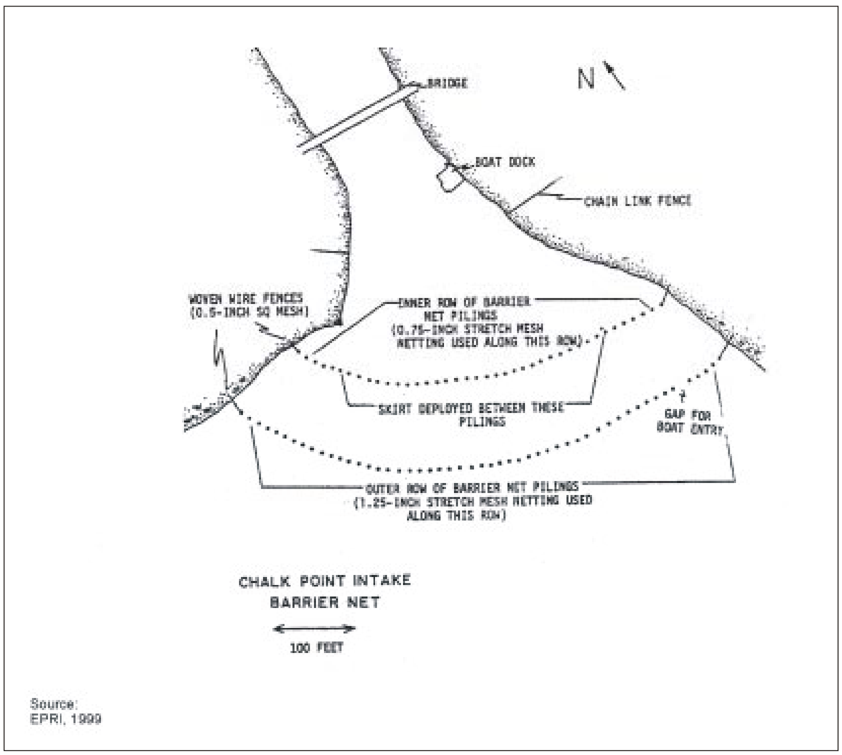

Figure 3-3. Chalk Point barrier net configuration.

3.4.2 Pilot Studies

Now that the final 316(b) Rule is in place, a good deal of interest has been generated in developing new fish protection technologies. Duke plans to monitor the development and testing of new technologies for potential use. Currently use of wedgewire screens in rivers that meet certain criteria is the only named EPA pre-approved technology. However the Rule provides a process that allows additional technologies to become listed as pre-approved technologies. New technologies can be so designated by providing information to demonstrate that, if installed in the proper waterbody type, the technology would have little trouble meeting the performance standard for which they are pre-approved. If other technologies more effective in terms of fish protection efficacy and cost-effectiveness become available, Duke will inform the Board that the new technology may be added to the PIC for evaluation at SBPP.

The results of the proposed IM&E sampling analysis in conformance with the Rule's calculation baseline will be available in 2006. If, at that time, a final decision has not yet been made regarding SBPP's retirement, and if use of restoration measures is not available, Duke may propose pilot studies in the 2006/2007 time frame to verify performance of feasible new technologies. Due to the relatively high cost of such studies and the potential for use of more cost-effective options, these studies will not be pursued unless necessary.

3.5 Use of Site-Specific Standards under Compliance Alternative 5

Duke plans to evaluate potential use of both the cost-cost and cost-benefit tests under Compliance Alternative 5. Use of these cost tests are provided to allow Phase II facilities to avoid costs that would be considered significantly greater than either the costs estimated by EPA for those facilities or the economic value of the site-specific environmental benefits that would be achieved. Should the evaluation of the current impingement reduction technologies and operational measures determine that the IM&E performance standard is not met or use of restoration for offsetting entrainment losses is not available these tests will be used in conjunction with the evaluation of technologies and operational measures discussed in Section 3.3 of the PIC.

Evaluation of Cost-Cost Test – EPA, in developing the national cost of implementing the Rule, considered the cost to comply for each Phase II facility. If the actual cost estimated for a facility to meet the performance standard, based on a site-specific analysis, is determined to be significantly greater than the cost estimated by EPA for the facility to comply, the facility can apply for a site-specific demonstration under the cost-cost test using Compliance Alternative 5. The site-specific standard would be that achieved by the use of the best performing technology (i.e., achieve the highest level of protection) or operational measure that would pass the cost-cost test. SBPP is identified as facility number DUN2032 in Appendix B of the Rule and the estimated annualized cost for SBPP was $74,691 in Appendix A.

However, EPA assumed that SBPP was only required to meet the impingement mortality reduction performance standard. As discussed in Section 2.2 of the PIC, the Units 1 and 2 and Unit 3 intakes will also be required to meet the entrainment reduction performance standard. EPA's estimates were based on flow and Unit 4 which is only subject to the impingement mortality reduction standard that makes up 33% of SBPP total flow of 417,400 gpm. Therefore, it is reasonable to assign 33% of EPA's Appendix A cost or $24,648 as the Appendix A cost for Unit 4. The Rule, for facilities that were assumed to be subject to impingement mortality reduction only but that are subsequently determined to be subject to entrainment, contains a cost adjustment factor[16] of 2.148 to adjust the cost to account for impingement. The portion of the Appendix A cost of $50,043 adjusted by the 2.148 correction factor increases the Appendix A cost for these Units to $107,492. The adjusted total Appendix A cost for SBPP is $132,140 ($24,648 + 107,492). This is the cost that Duke plans to use for the purpose of evaluating the cost-cost test.

Evaluation of Cost-Benefit Test – The economic value of the environmental benefit of meeting the performance standards will also be evaluated. This evaluation will include the cost of any impingement mortality reduction technologies. It will also include evaluation of the costs of meeting the entrainment performance standard and the resulting benefit of meeting the entrainment standard. This analysis would include consideration of impact information already conducted by Duke as part of the SBPP NPDES discharge permit renewal process. The approach for this analysis is further discussed in Appendix C of the PIC.

[16] Federal Register, Vol. 69, No. 131, 7/9/04, pg 41647, col. 1 first paragraph.

4.0 Summary of Existing Biological Studies and Plans for IM&E Characterization Studies and Analysis

The Rule requires that a summary of historical IM studies and/or physical and biological studies conducted in the vicinity of the CWIS be provided as well as study plans for any new IM studies to be conducted. The previous operators of the SBPP (San Diego Gas and Electric Company) conducted one year of IM&E sampling at SBPP from February 1979 through January 1980. Two additional years of entrainment and source water sampling were conducted by Duke Energy at nine stations in south San Diego Bay, as part of the NPDES renewal process (**Figure 4-1).** Sampling was conducted monthly from January 2001 through January 2002 and bi-monthly from December 2002 through October 2003. Impingement sampling was conducted weekly from December 2002 through December 2003. A summary of the recent studies follows.

Because of the recent IM&E sampling conducted in conjunction with the SBPP NPDES discharge permit renewal process, no new IM&E studies are being proposed. Rather, existing data will be used for the purpose of preparing the IM&E Baseline Characterization Study component of the Comprehensive Demonstration Study (CDS). Due to the recent detailed impingement and entrainment sampling in 2003 and 2004, this will be representative of current biological conditions. Detailed information presented in the report submitted to the Board provides documentation that the data were collected using appropriate QA/QC methods.[17]

4.1 Entrainment Studies Summary

The 2001–2003 entrainment study estimated the number of the planktonic fish, *Cancer* crab, and spiny lobster larvae in front of the intakes and at other locations in south San Diego Bay. Plankton samples were collected with fine-mesh nets using methods similar to those used in other long-term fishery investigations. Preserved samples were sorted in the laboratory and the fishes and target invertebrates were identified to the lowest taxon practicable.

[17] Duke Energy South Bay L.L.C. 2004. SBPP Cooling Water Effects on San Diego Bay: Volume II: Compliance with 316(b) of the Clean Water Act for the South Bay Power Plant. *Appendix B: Procedures for the Sorting and Identification of Plankton Samples.*

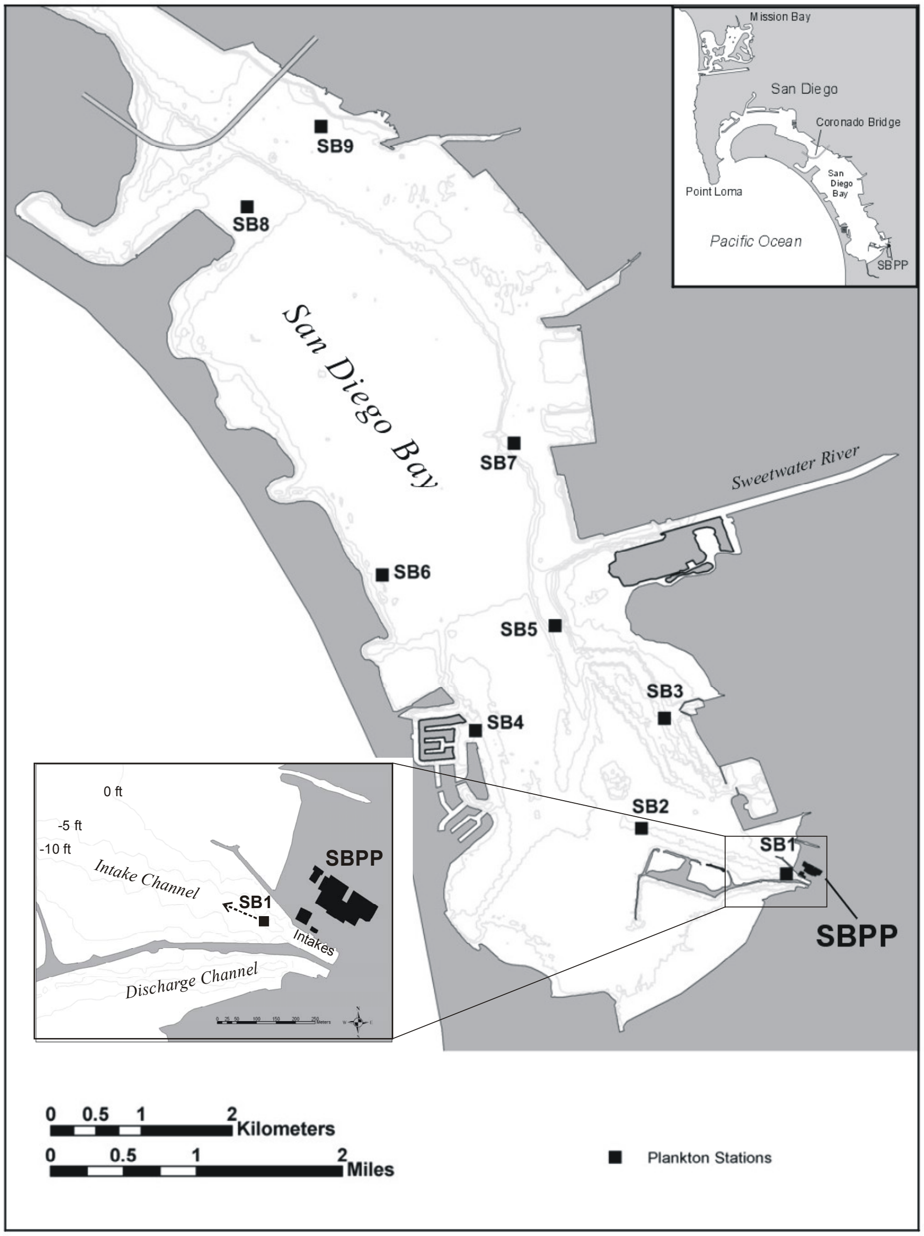

Figure 4-1. Location of SBPP entrainment (SB1) and source water plankton stations (SB2–SB9).

Inset shows entrainment station in relation to SBPP. Impingement samples were collected directly from the intake screening system at SBPP.

Entrainment effects were assessed using three independent models. Two of the models, Fecundity Hindcasting (*FH*) and Adult Equivalent Loss (*AEL*), used species life history information to estimate the potential numbers of adults represented by the entrainment losses. The third approach, Empirical Transport Modeling (*ETM*), compared entrainment larval concentrations to source water larval concentrations to calculate the effects of larval removal on the standing stock of larvae in south San Diego Bay. The source water volume used in the *ETM* calculations comprised the area of the bay south of the Coronado Narrows and encompassed the South and South-Central eco-regions of San Diego Bay. Tidal exchange ratios, source water volumes, cooling water volumes, larval concentrations, and larval durations and were all variables used in the *ETM* calculations.

Conservative assumptions were used for developing the best estimates of losses due to power plant operation. For example, even though cooling water pumping volumes were 68–73% of maximum in the 2001–2003 period, maximum pump volumes were used in calculating potential entrainment and impingement losses. Further, although there is evidence that some organisms survive impingement and entrainment, the calculations assumed no survival.

The results of the 2001 and 2003 entrainment sampling study periods were as follows:

- Two taxa, CIQ gobies (comprised of arrow, cheekspot, and shadow gobies) and anchovies (comprised of bay and deepbody anchovies), comprised greater than 95% of the total estimated entrained larvae for both sampling periods. These are small forage fishes common in bays of southern California. Detailed assessments of entrainment effects were completed for the five taxa that comprised 99% of all of the entrained fish larvae (**Table 4-1**).
- California halibut, white seabass, and other commercial or recreational fishery species comprised less than 0.1% of the total estimated entrained larvae during both sampling periods. Because of their low abundances in entrainment samples, power plant effects on fishery species were not evaluated with the same modeling approaches used for the more abundant non-fishery taxa.
- During the first sampling period the greatest concentrations of larval fishes at the entrainment station occurred during June 2001, while during the second sampling period the greatest concentrations occurred during December 2002.
- The larval fish community composition in south San Diego Bay changes along a gradient from north to south as a function of distance from the mouth of the bay. The abundances and numbers of species were lowest at the entrainment station and source water stations in the southernmost end of the bay.
- *ETM* estimates of entrainment mortality were 3–28%, although an estimate of 50% was calculated for longjaw mudsucker (a species of goby) during the 2003 sampling period. This estimate was affected by the reduced bi-monthly sampling effort during 2003.

The *ETM* estimate of 17% from 2001 was considered to be more representative of entrainment effects on this species.

- The major results were very similar to the previous 316(b) study completed by SDG&E in 1980. Entrainment estimates for several of the species from this study were remarkably similar to estimates from the previous study. Our *ETM* estimates were similar to, or within the range of estimated effects on larval standing stock from the previous study.
- There was insufficient life history information and entrainment abundance to model adult equivalent losses for any of the fishery species. Silversides were the only taxa with assessment results that also had commercial landings data that could be used to value the losses. The *ETM* estimates of proportional larval mortality suggest losses of approximately 450,000 adult silversides. This extrapolation assumes a stable adult population and no compensation, and would be very conservative for silversides due to the large variability in the adult population that far exceeds the 15% *ETM* estimate. The dollar value of entrainment losses of silversides was approximately $13,000.

Table 4-1. Summary of larval fish entrainment data analyses for 2001 and 2003.

	Percent Composition in Entrainment		Estimated Annual Larval Entrainment (in billions)		Estimated Annual Source Population (in billions)		Estimated Percent Larval Losses		Estimated Adult Equivalent Losses (in millions)	
Taxon	**2001**	**2003**	**2001**	**2003**	**2001**	**2003**	**2001**	**2003**	**2001**	**2003**
CIQ goby complex	75.6	89.0	1.83	1.39	8.51	5.21	21.5	26.7	2.17	1.65
Anchovies	21.3	6.8	0.52	0.11	4.95	1.39	10.5	7.9	0.21	0.05
Combtooth blennies	0.9	1.5	0.02	0.02	0.65	0.59	3.1	3.4	0.02	0.02
Longjaw mudsucker	0.9	1.6	0.02	0.02	0.12	0.04	17.1	50.2	<0.01	<0.01
Silversides	0.6	0.6	0.01	0.01	0.07	0.05	14.6	14.9	*	*

* Information unavailable to compute model estimate.

The results indicate low potential for entrainment effects on the five taxa analyzed. The increase in mortality due to entrainment, calculated for continuous full power operation, may be compensated for by increased survival of later larval and juvenile stages. The similarity in the estimates of entrainment losses between the 1979–1980 and 2001–2003 studies indicates that compensatory mechanisms are operating to maintain long-term stability in these populations. There is also evidence that some of these taxa may have behavioral adaptations to living in high current environments that would help reduce entrainment effects. The conclusion from this study that entrainment due to the SBPP cooling water system under full operation represents low potential risk to the target taxa populations is the same as the conclusion from the previous 316(b) Demonstration conducted by SDG&E in 1979–1980.[18]

4.2 Impingement Studies Summary

Impingement was studied weekly over 24-hr periods from December 2002 through November 2003 by recording the numbers and weights of all fishes and selected macroinvertebrates that were rinsed from the screens of Units 1 & 2 and Units 3 & 4. Results from the 2002–2003 twelve-month impingement sampling program were as follows:

- A total of 50,970 individual fishes comprising approximately 50 taxa was collected from the 52 weekly impingement samples. The fishes weighed a total of 74 kg (163 lb).
- Total annual impingement of fishes under full operation flow rates was estimated to be 385,588 individuals weighing 556 kg (1,226 lb).
- The most abundant taxon both numerically and by weight impinged was anchovies (*Anchoa* spp.), comprising about 93% by number and 40% by weight of all of the fishes impinged. Most were juveniles.
- Crustaceans (shrimps, crabs, and lobster) and cephalopods (squid and octopus) were studied in more detail than other invertebrates because of their potential fishery value. A total of 1,106 crustaceans and cephalopods from 30 taxa was collected during the study. These individuals had a total wet weight of 3.1 kg (6.8 lb). In all, 80 invertebrate taxa were identified in the impingement samples.
- The estimated total annual impingement of target invertebrates under full operation was 9,019 individuals, with an estimated wet weight of 22.6 kg (49.8 lb).
- Most of the fishes impinged, over 96% of the total abundance and 87% of the biomass, were not commercially or recreationally fished species.
- There were several differences between the previous impingement study results[19] and the current one. The estimated annual impingement in the prior study was 28,174 fishes weighing 4,459 kg (9,830 lb), while in the current study it was estimated at 385,588 fishes weighing 556.5 kg (1,226.4 lb).
- Anchovies (mainly juvenile slough anchovy) were more abundant in the recent study than the earlier study whereas round stingray, specklefin midshipman, diamond turbot, California halibut, and Pacific butterfish were less abundant.

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[18] San Diego Gas & Electric Company (SDG&E). 1980. South Bay Power Plant Cooling Water Intake System Demonstration Summary. Prepared for California Regional Water Quality Control Board San Diego Region, San Diego CA.

[19] Ibid.

- The estimated ex-vessel value for impingement losses under full design flow was less than $2,000 per year for the small numbers of fishes with commercial fishery landings.

The small magnitude of estimated impingement effects under full design flow indicates that SBPP operation represents a low potential risk to target taxa populations. The previous 316(b) Demonstration conducted by SDG&E in 1979–1980 also concluded that impingement effects were insignificant.[20]

4.3 Plans for Analysis of Existing IM&E Data

Consistent with the Rule, Duke will characterize the facility's entrainment and impingement mortality using contemporary data collected from January 2001 through October 2003. The Rule at §125.95(b)(3)(ii) states in reference to the IM&E Characterization Study data, "these may include historical data that are representative of the current operation of your facility and the biological conditions at the site." As noted in Section 2.2, the capacity utilization rate exceeded 15% for Units 1, 2, and 3 in 2000-2004, and Unit 4 exceeded 15% in 2000 only. The EPA points out in the Rule's preamble on page 41617[21] that some commenters on the Rule "…suggested that the calculation baseline should reflect unrestricted operation at full design capacity year-round to avoid continually changing the baseline." However, EPA chose not to base the calculation baseline on this approach stating, "EPA chose not to incorporate capacity into the calculation baseline, as the definition is not dependent upon intake flow volumes." EPA has chosen to adopt the "as built" approach: as stated in §125.93, a facility may choose to use the current level of impingement mortality and entrainment as the calculation baseline. For facilities with lower capacity utilization such as SBPP, estimating entrainment based on actual flow is also consistent with the Rule's baseline calculation reference to "the baseline practices and procedures." It is therefore appropriate for SBPP to calculate the level of IM&E by determining impingement and entrainment as a function of circulating water pump operation rather than design flow.

The baseline characterization based on actual circulating water pump operation will remain the baseline unless operations change. In the event circulating water pump operation increases, a change in facility operations would result, and additional compliance measures would be required. The 316(b) Rule contemplates review of 316(b) compliance during each permit cycle.[22] This ensures that if operations such as increased circulating water pump operation occur, the permit can be modified to ensure that the performance standards will continue to be achieved.

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[20] Ibid.

[21] Federal Register, Vol 69, No.131, 7/9/04, pg. 41617, Column 2.

[22] The Rule at §125.98(a)(3) states, "At each permit renewal, you (referring to NPDES permitting authority) must review the application materials and monitoring data to determine whether new or revised requirements for design and construction technologies, operational measures, or restoration measures should be included in the permit to meet applicable performance standards in §125.94(b) or alternative site-specific requirements established pursuant to §125.94(a)(5)."

5.0 Summary of Past or Ongoing Consultation with Agencies

The Rule requirements for the PIC ask for a summary of past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to this study and a copy of written comments received as a result of such consultations. Duke believes that the goals of this summary are to provide San Diego Regional Water Quality Control Board with full perspective on the historical permitting of the CWIS as well as potential concerns raised by relevant fisheries management or other natural resources agencies.

The Board has assumed the role of lead agency in regulatory matters associated with SBPP since it issued its first series of waste discharge requirements for the facility in 1969. SBPP has been operating at its current location in Chula Vista, California since 1960. On April 23, 1999, San Diego Gas and Electric (SDG&E) sold SBPP to the San Diego Unified Port District, which concurrently leased the plant to Duke Energy South Bay, LLC. Duke Energy has assumed all responsibility, coverage, and liability in regards to the NPDES permit. On May 4, 2001, Duke Energy submitted an application for renewal of NPDES Permit No. CA0001368.

On March 22, 2002, the Board issued Tentative Order No. R9-2002-0022. In the tentative order, Board staff concluded that some of the previous studies of the power plant's intake and discharge effects on the water quality and biological resources of south San Diego Bay might be outdated and may not reflect current plant operations or be representative of existing conditions. Although this tentative order was never approved, a letter dated May 24, 2002 from the Board’s executive director to Duke Energy South Bay, LLC described several open issues regarding the effects of the power plant’s intake and discharge systems. The studies described in the Board’s directive were designed to address these open issues and to collect additional information on present conditions in the power plant’s cooling water discharge and source water areas. Both the California Department of Fish and Game and National Marine Fisheries Service expressed support for staff’s recommendation of an updated entrainment and impingement study. These agencies, as well as the U.S. Fish and Wildlife Service and EPA, played integral roles in the Technical Working Group that oversaw the study design and were allowed to comment on draft reports.

Preliminary results from the studies conducted jointly by Tenera Environmental Services and Merkel and Associates for Duke Energy were presented to the Board’s Technical Working Group in February, June, and October 2003. Board Staff solicited public comment on draft versions of “SBPP Cooling Water System Effects on San Diego Bay: Volume I: Compliance with Section 316(a) of the Clean Water Act A.2 for the South Bay Power Plant, and Volume II: Compliance with Section 316(b) of the Clean Water Act for the South Bay Power Plant” that were posted on the Board’s website in August 2004.

5.1 Section 316(b)-Specific Consultations

Duke has been unable to find specific correspondence from the Board or EPA regarding the Section 316(b) compliance status of the SBPP in the late 1970s and early 1980s. Section 316(b) studies were performed over the past three decades that included analysis and reporting that undoubtedly generated review and possibly correspondence between SDG&E and the regulatory agencies that may still reside in the Board archives, but is not available from Dukes records or files.

Duke had numerous conversations with the Board staff during the renewal of SBPP's NPDES permit issued by the Board in November 10, 2004. The collection and analysis of 316(b) information during 2003 to 2004 period and including twelve months of source water and entrainment data collected in 2001 form the basis of the facility's permit renewal.

In addition to addressing the issues raised by the Board, the studies were designed to fulfill requirements of the federal CWA Section 316(a) for discharge effects and Section 316(b) for intake effects, prior to enactment of the Phase II 316(b) rule. However the study plan and analyses of the peer-approved studies fully conform to methods and standards of IM&E studies for the new Rule characterization of impingement and entrainment. The study design, sampling and laboratory processing methodologies, data, and assessment of impacts from these Section 316(a) and 316(b) studies are presented in two volumes. Volume I is an assessment of the effects of the cooling water discharge system, which fulfills CWA Section 316(a) requirements, and Volume II is an assessment of the effects of the circulating water intake system, which fulfills CWA Section 316(b).

5.2 Other Relevant Consultations

The study design for the SBPP cooling water intake technology evaluation required under Section 316(b) of the federal CWA was developed in cooperation with representatives of the Board, California Department of Fish and Game, U.S. Fish and Wildlife Service, NOAA Fisheries, and other interested parties. A number of workshops were held to discuss the study plan design, implementation and preliminary data analysis. The study design was based on a survey and compilation of available background literature, results of recently completed SBPP intake studies, and cooling water system studies at other power plants.

Although Duke worked closely with agency representatives in workshop settings during the development of the 2002 316(b) Study Plan and final 316(b) assessment analysis and report, Duke had no separate consultations with fisheries or other agencies relative to impingement and entrainment of fisheries at SBPP, with the exception of a meeting with Bob Hoffman of NOAA Fisheries in his Long Beach office to discuss ideas of restoration to offset entrainment and impingement effects of the SBPP CWIS. Communications with the California Department of Fish and Game and the U.S. Fish and Wildlife Service have indicated that there are no state- or federally-listed fish species in the vicinity of the CWIS that are at risk to entrainment or impingement. In addition, none of the green sea turtles (a species listed by USFWS as endangered) that commonly occur in the vicinity of the SBPP warm water discharge, particularly during the winter season, have been impinged by the plant.

6.0 Schedule for Information Collection and Preparation of CDS Documents

The Rule allows facilities with NPDES permits that expire within four years of the date of publication of the Rule in the Federal Register (July 9, 2004) up to three years and six months to submit the CDS (125.95(2)(ii)). The Board has issued a permit to Duke for SBPP that requires submittal of the Final CDS in November of 2007. This schedule is accelerated somewhat from the Rule since Duke plans to primarily rely on existing impingement and entrainment studies for the Impingement Mortality and Entrainment Characterization Baseline.

Assuming that the Board provides comments within the 60-day period suggested in the Rule (i.e., January 6, 2006), Duke will make any necessary changes to modify the PIC within 30 days and provide a revised PIC to the Board by February 5, 2006. At this point, PIC information gathering will be initiated. The first major task will be to complete the IM&E Characterization Study data analysis using existing information and initiate the study to evaluate and quantify the benefit of existing design and operational measures discussed in sections 3.1 and 4.3 of the PIC. Completing this analysis is critical in order for Duke to make a final decision on compliance alternatives. It is anticipated this analysis will require approximately four months to complete (i.e., June 5, 2006). Upon PIC approval, Duke will also initiate discussions and work with appropriate state and federal agencies to identify potential restoration projects of interest for use under compliance alternatives 3 and/or 5. As noted, a Court will issue a decision on the on-going Phase II litigation, so any impact of that decision on the currently available compliance alternatives and compliance options can be considered in making Duke's final compliance decision. The Court has issued a briefing schedule and final oral briefings are currently scheduled for April 24, 2006. It is anticipated the Court will render a final decision within one to three months or approximately by the middle of 2006.

If a decision has not yet been made on plant retirement, Duke will proceed with analysis of compliance alternatives. Based on completion of analysis of the biological data, discussions to identify restoration projects and availability of the restoration option for compliance, Duke should be in a position to make a final compliance decision shortly after the Phase II Rule litigation decision. At this point, the schedule will be determined by the compliance alternative and option selected. If the compliance alternative requires use of technologies, the need for laboratory or site-specific pilot studies are likely to be necessary. Such studies would be initiated in the summer of 2006 and take up to one year to complete.

Preparation of the CDS will depend on the final compliance alternative(s) selected as follows:

- Use of Technologies or Operational Measures – It is anticipated that it will require approximately 6–12 months to complete pilot studies and 4–5 months to complete draft and final CDS documents based on the technology and compliance assessment information (i.e., Design and Construction Technology Plan and Technology Installation and Operation Plan).

- Use of Restoration – Duke prefers to use restoration measures to achieve compliance with 316(b) Phase II impingement and entrainment performance standards. Efforts are underway to identify and create a restoration plan. It is anticipated that preparation of this plan will require 6–12 months to provide the information necessary that will address the Phase II requirements for plan specification, benefits valuation, and cost analysis and restoration monitoring plan. It is therefore likely that a final CDS based on restoration can be submitted between the mid-year or November 2007 as specified in the permit.

- Use of Site-Specific Standards – Should Compliance Alternative 5 be used as a component of the CDS, it will be necessary to prepare a Comprehensive Cost Evaluation Study. If the Cost-Benefit test is used it will be necessary to prepare a Benefit Valuation Study. In addition, if a technology or operational measure is used as part of Compliance Alternative 5 the technology and compliance assessment information documents will also be required. Thus, the full allowable schedule will be necessary.

The Rule recognizes that the CDS studies are an iterative process[23] and allows facilities to modify the PIC based on new information. Duke may request Board approval of an amendment to this PIC, based on new information relative to technologies and operational measures, use of restoration measures, Phase II Rule litigation, or subsequent Agency guidance. Such information may require modification of the currently proposed schedule.

[23] See Rule preamble first column pg 41235 of Federal Register/Vol. 69, No. 131/Fri 7/9/04.

Duke Energy South Bay LLC

316(b) Proposal for Information Collection for South Bay (San Diego) Power Plant

Appendix A

Restoration Measures to be Evaluated for 316(b) Compliance at Duke's South Bay Power Plant

Appendix A: Restoration Measures to be Evaluated for 316(b) Compliance at Duke's South Bay Power Plant

The final Phase II Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available (BTA) on a site-specific basis. Specifically, EPA's final Phase II Rule states the following requirement relative to the use of the restoration approach:

> Facilities that propose to use restoration measures must demonstrate to the permitting authority that they evaluated the use of design and construction technologies and operational measures and determined that the use of restoration measures is appropriate because meeting the applicable performance standards or requirements through the use of other technologies is less feasible, less cost-effective, *or* [emphasis added] less environmentally desirable than meeting the standards in whole or in part through the use of restoration measures.

Types of Restoration Applicable to Section 316(b)

The Rule does not specify the types of restoration measures that can be used. This lack of specification provides flexibility in developing/proposing a restoration approach. Restoration measures that have been used at other power stations to meet Section 316(b) requirements under state regulatory programs include:

- Wetland restoration (e.g., Public Service Electric & Gas (PSEG) Delaware Bay wetland restoration program for the Salem Generating Station)(Weinstein et al. 2001).

- Fish stocking (e.g., Mirant Mid-Atlantic fish hatchery at the Chalk Point Station (Bailey et al. 2000); Exelon's (formerly Commonwealth Edison) walleye hatchery at Quad Cities Station on upper Mississippi River (LaJeone and Monzingo 2000); and Southern California Edison's white sea bass hatchery.

- Submerged aquatic vegetation (SAV) restoration (e.g., Southern California Edison's kelp restoration for the San Onofre Nuclear Generating Station) (Deysher et al. 2002).

- Provision of fish passage (e.g., fish ladders or dam removal) at non-hydropower projects (e.g., PSEG fish ladders in Delaware Bay tributaries for the Salem Generating Station).

- Contribution to, or maintenance of, a restoration fund related to impacts associated with the re-powering of Duke Energy Moss Landing Power Plant in Moss Landing, California. See:

  http://www.duke-energy.com/businesses/plants/own/us/western/mosslanding/reports/

- Water quality improvements (e.g., riparian area protection or implementation of non-point source best management practices) that minimize sediment/pollutant runoff thereby resulting in fishery habitat improvements, and practices that increase dissolved oxygen content in waterbodies thereby increasing available habitat for fish spawning and survival. While this approach is plausible, there are no known existing examples of such a 316(a) or 316(b) restoration project.

Potential Restoration Measures for SBPP California Facilities

SBPP may wish to consider the following example restoration projects[24] to attain the impingement mortality and entrainment reduction performance standard or as part of a site-specific standard developed by the permit director.

SBPP program might include restoration alternatives such as:

- restoring degraded wetlands in proximity to and including the salt evaporation ponds in south San Diego Bay to mitigate impacts to marine fish populations caused by estimated mortality to fish eggs and larvae;
- constructing eelgrass beds to mitigate intake effects on the larvae entrained from the areas shallow habitat (note: this may also offset thermal effects);
- co-funding a marine fish hatchery program intended as supplementary mitigation for larval fish impacts;
- co-funding ongoing restoration efforts of the Sweetwater Marsh to offset the entrainment losses of long-jawed mudsucker larvae from this habitat, and
- funding resource and conservation agency staff oversight and monitoring of these mitigation projects.

These projects are listed because of their known interest to fish and wildlife agencies in California and because design and implementation information is readily available:

[24] Projects listed are examples – opportunities for creative restoration projects are unlimited and depend upon corporate interests and negotiations with state and federal resource agencies.

Fish stocking – While forage species (e.g., gobies, anchovies, sardines) are the most common species impacted at California power plants, stocking of these species to compensate for the losses would not be of interest to any of the federal and state fish and wildlife agencies. The objective of a supplementation program would be to identify a 'species of concern', the stocking of which would compensate ('comparable to, or substantially similar to') for the production foregone as measured by a game fish's consumption (e.g., X northern anchovy are equivalent in energy or food consumption to Y white sea bass or other recreational or commercial fishes of concern). This is the approach used by Potomac Electric Power Company for estimating annual hatchery production of striped bass to compensate for bay anchovy (a forage species) losses at their Chalk Point Generating Station on the Patuxent River in Maryland.

Fish stocking involves the direct supplementation (stocking) of a fish species of concern to aid restoration efforts for that species. Restoration stocking (as opposed to recreational gamefish stocking) is generally pursued where the species of interest has been completely extirpated or where associated habitat restoration is unlikely to contribute to stock restoration. For example, the Georgia Department of Natural Resources (GDNR), following six years of study, recently initiated a long-term effort to restore lake sturgeon to the Coosa River system in Georgia/Alabama. This species is listed as threatened throughout the U.S. and has disappeared completely from much of its original range, including the Coosa River. Through a collaborative effort between several state and federal agencies, GDNR released 1,100 fingerlings to the Coosa River in December 2002 as the first step towards returning lake sturgeon to a healthy, self-sustained population in the river. See:

http://georgiawildlife.dnr.state.ga.us/content/displaycontent.asp?txtDocument=305

A similar program may be of interest in California, particularly for the southern steelhead salmon or coastal rockfishes (*Sebastes* spp.), both of which are federal and state listed endangered and threatened species along the California coast. See:

http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?state=CA

California Department of Fish and Game (CDFG) and the Board (and U.S. Fish and Wildlife Service /NOAA Fisheries) may support SBPP's participation in a program to restore rare, threatened, and endangered fish to native habitat. Mirant Mid-Atlantic Inc. currently raises and stocks Atlantic sturgeon at its Chalk Point Hatchery Facility on the Patuxent River for the State of Maryland, Department of Environmental Protection. American shad restoration to the Susquehanna River basin in Maryland/Pennsylvania has been accomplished in part via stocking of juvenile shad and via provision of fish passage (St. Pierre 2003, Hendricks 1995). Restoration stocking (e.g., for southern steelhead) could also be combined with provision of fish passage (i.e., dam removal or fish ladders). This form of restoration is discussed further below.

Fish stocking program support could be via hatchery operation developed on or off plant property (e.g., Southern California Edison [SCE] funds the operation of a fish hatchery in Carlsbad, CA for culturing and stocking California sea bass. Such a hatchery would be operated and maintained under state and federal oversight. Alternatively, SBPP could possibly negotiate a direct annual contribution of funds to a state and federal hatchery supplementation program or a private foundation. For example, the Hubbs/Sea World Research Institute operates the SCE fish hatchery for San Onofre Nuclear Generating Station (SONGS) mitigation. While hatchery or stock supplementation programs can be controversial due to concerns over protection of natural genetic integrity, California resource agencies, based on their approval and development of SCE's SONGS Mitigation Project, supported stocking as compensation for fish losses. CDFG and NOAA Fisheries also have a long-term fish hatchery program to support maintenance and restoration of anadromous salmonids in California coastal rivers (CDFG/NMFS 2001). California resource agencies' experience with hatchery supplementation may mean that they could be receptive to a hatchery program in southern California established by SBPP as compensation for SBPP impingement and entrainment losses. For example, when operating at design capacity, the SCE funded hatchery is expected to exceed compensation for the total SONGS fish losses estimated by an expert panel created by the California Coastal Commission. See:

http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm

For approximate cost references, SCE provided $4.7 million in funding for the white sea bass hatchery which began operation in late 1996. Similarly, the Potomac Electric Power Company (PEPCO) established an aquaculture facility at their Chalk Point Station at a capital cost (1990 dollars) of $1 million. Annual O&M has been approximately $175,000 to $250,000 depending on the species and number of organisms raised and stocked in Maryland waters.

<u>Habitat Protection Program Participation</u> – The importance of wetlands, in-stream habitat, and riparian areas as aquatic habitat for fish and invertebrates, and as habitat for wildlife is reviewed in EPRI (2003). Wetland restoration or habitat restoration in general, is becoming increasingly popular across the U.S. and there is a growing case history with use of habitat restoration as a 316(b) mitigation approach (EPRI 2003). In California, over 90% of its historic wetlands and 95% of historic streamside trees, shrubs, and ground vegetation has been lost from urbanization, agricultural conversion, logging, and flood control (USFWS 2001). Habitat restoration, therefore, should be a major interest to federal and state resource agencies and non-governmental organizations (NGOs) in California. The following identifies federal, state, and private restoration programs that provide information which SBPP may find of value for establishing their own restoration program or offer opportunities to collaborate on potential restoration projects.

Example programs include:

Duke Energy's Morro Bay Modernization Project Habitat Enhancement Program – as part of the power plant modernization, Duke Energy has volunteered to fund a program that would reduce sedimentation and the other major factors undermining the Morro Bay's productivity.

The concerns for Morro Bay and the target of Duke's proposal are the issues identified by the Morro Bay National Estuary Program's (MBNEP) Comprehensive Conservation Management Plan (CCMP). Those issues include sedimentation, loss of habitat, and nutrient pollution. Duke's proposal is their preferred alternative to CEC requesting dry cooling operation. The Central Coast Board's staff agrees with Duke's proposal and believes that habitat enhancement would yield greater long-term benefits for the Bay. Duke Energy's proposal would fund habitat enhancement projects authorized by the Board and managed through professional groups like the MBNEP, which have plans and programs to reduce sedimentation and other factors undermining the Bay's productivity. The special value of habitat enhancement is that it not only addresses marine biology, but also protects and enhances habitat for birds and other animals and sustains important recreational resources for the community. Documents describing the program in detail can be downloaded from the noted website. Because of recent economic conditions across the U.S., Duke has canceled plans for modernizing the Morro Bay Power Plant and, as a result, their habitat enhancement project has not been implemented. See:

http://www.duke-energy.com/businesses/plants/own/us/western/morrobay/reports/

SCE's SONGS Mitigation: The proximity of SONGS and its ongoing restoration program is a key starting point relative to any restoration project initiated by SBPP for impacts at its southern California generating stations. The California resource agencies and local non-governmental organizations will likely heavily rely on lessons learned during the negotiation and development of the SONGS Program. The SONGS Marine Mitigation Program is a multi-faceted environmental enhancement program intended to mitigate unavoidable impacts to the marine environment resulting from operation of the SONGS Units 2&3 cooling water systems. See:

http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm

PSEG's Delaware Bay Estuary Enhancement Program*:* This is the largest restoration program the U.S. implemented as compensation for impingement and entrainment losses at a power station. Established in 1995, this program was negotiated with New Jersey Department of Environmental Protection (NJDEP) as a mitigative action for fish losses at the Salem Nuclear Generating Station in lieu of implementing a closed-cycle cooling system. Principally focused on the restoration of approximately 10,000 acres of former salt hay farms to natural estuarine salt marsh in the lower Delaware Estuary, the program also includes provision of fish passage in combination with some limited fish stocking to support restoration of anadromous (American shad and river herring) fish stocks. Details of the program can be found in Weinstein et al. (2001). In a following section, the method used by PSEG to scale (i.e., convert fish loss to acres of equivalent wetland habitat) the size of the requisite restoration project is demonstrated. The PSEG incurred costs to date for the ongoing restoration project, including capital, O&M, and monitoring exceed $100 million or $9,350/acre (EPRI 2003).

Santa Monica Bay Restoration Commission: In recognition of the need to restore and protect the Santa Monica Bay and its resources, the State of California and the U.S. EPA established the Santa Monica Bay Restoration Project (SMBRP) as a National Estuary Program in December 1988. The Project was formed to develop a plan that would ensure the long-term health of the 266 square mile Bay and its 400 square mile watershed, located in the second most populous region in the U.S. That plan, known as the Santa Monica Bay Restoration Plan, won state and federal approval in 1995. Since then, the SMBRP's primary mission has been to facilitate and oversee the implementation of the Plan. See:

http://www.santamonicabay.org/site/aboutus/layout/index.jsp

On January 1, 2003, the SMBRP formally became an independent state organization and is now known as the Santa Monica Bay Restoration Commission (SMBRC). The Santa Monica Bay Restoration Commission continues the mission of the Bay Restoration Project and the collaborative approach of the National Estuary Program but with a greater ability to accelerate the pace and effectiveness of Bay restoration efforts. Restoration activities are based on a comprehensive plan of action for Bay protection and management, known as the Bay Restoration Plan, that was approved by Governor Pete Wilson in December 1994 and by U.S. EPA Administrator Carol Browner in 1995. The Plan identifies almost 250 actions, including 74 priority actions, that address critical problems such as storm water and urban runoff pollution, habitat loss and degradation, and public health risks associated with seafood consumption and swimming near storm drain outlets. The Plan outlines specific programs to address the environmental problems facing the Bay and identifies implementers, timelines, and funding needs.

Implementation of the Plan is the focus of current efforts. Securing and leveraging funding to put solutions into action, building public-private partnerships, promoting cutting-edge research and technology, facilitating a stakeholder-driven consensus process, and raising public awareness in order to restore and preserve the Bay's many beneficial uses are key objectives of the SMBRC.

National Oceanic and Atmospheric Administration (NOAA) Community-based Restoration Program (CRP)**:** This program applies a grass-roots approach to restoration by actively engaging communities in on-the-ground restoration of fishery habitats around the nation. The CRP emphasizes partnerships and collaborative strategies built around restoring NOAA trust resources and improving the environmental quality of local communities. The program is: (1) providing seed money and technical expertise to help communities restore degraded fishery habitats, (2) developing partnerships to accomplish sound coastal restoration projects, and (3) leveraging resources through national, regional, and local partnerships. This program is one of the services of the NOAA Restoration Center. This Center's mission is to enhance living marine resources to benefit the nation's fisheries by restoring their habitat. Working with others, the Center achieves its mission by (1) restoring degraded habitats, (2) advancing the science of coastal habitat restoration, (3) transferring restoration technology to the private sector, the public, and other government agencies, and (4) fostering habitat stewardship and a conservation ethic.

Recently, under the community-based program, NOAA awarded $250,000 to the Gulf of Mexico Foundation for habitat restoration in the five states bordering the Gulf of Mexico. EPA, under their Gulf of Mexico Program (see following) similarly awarded $90,000 to the Foundation. These awards launch a major new effort to reclaim essential fish habitats of the Gulf of Mexico by implementing field efforts to restore and improve marine and coastal habitats that have been degraded or lost. See:

http://www.nmfs.noaa.gov/habitat/restoration/

U.S. Fish & Wildlife Service Partnership for Fish & Wildlife*:* This program is supported by funds from federal and state agencies, private landowners, and non-governmental organizations (e.g., Ducks Unlimited, CDFG, The Nature Conservancy). The program is a voluntary partnership program with a goal to restore wetlands and other vital habitats on private land with 70% of the current funding coming from private sources. The remaining funds, along with restoration design and technical assistance is provided by USFWS. State resource agencies, such as CDFG, work with USFWS to help establish priorities and identify focus areas. The restoration of degraded wetlands, native grasslands, streams, riparian areas, and other habitat to conditions as close as possible to natural is emphasized. The Partnership for Fish and Wildlife Program is important for restoration of critical habitats in California (USFWS 2001). SBPP financial support to the program and potential in-kind service could potentially be negotiated as compensation for impingement mortality and entrainment at their power plants in southern California. See:

http://partners.fws.gov/index.htm

Coastal America's Corporate Wetland's Restoration Partnership (CWRP): is a program designed to foster collaboration between the federal government, state agencies, and private corporations. Private corporations that participate in this national program will donate funds for either site-specific wetland or other aquatic habitat restoration projects or provide matching funds to a national or regional effort in support of aquatic ecosystem restoration activities. Projects that will receive funds from the CWRP will all be approved Coastal America projects while federal agencies will assist in their proper execution. The Coastal America Partnership will coordinate among all of its Regional Implementation Teams to identify the appropriate private foundation or state trust fund that will receive funds from the CWRP. <u>This organization will not likely accept support in response to regulatory requirements. However, the organization is a source of wetland restoration information and unique partnerships may be arranged</u>. See:

http://www.coastalamerica.gov/text/cwrpoperating.html

<u>Alternative Restoration Measures</u> – the above measures have been identified as the most likely restoration approaches that would be receptive to the Board and other federal and state resource agencies. Other potential approaches include nonpoint source pollutant runoff abatement programs and contaminated sediments restoration. While these types of efforts focus on water quality improvements, the long-term benefit is improved fish and shellfish habitat. Such efforts

would have to demonstrate a clear linkage between the two as compensation for impingement mortality and entrainment losses at SBPP. The California Coastal Commission is implementing a statewide Non-point Source (NPS) Program. See:

http://www.coastal.ca.gov/nps/npsndx.html

Elements of the plan include management measures for reducing runoff pollution from agriculture, silviculture, urban areas, marinas and recreational boating, and via hydromodification (includes modification of stream and river channels, dams and water impoundments, and streambank/shoreline erosion). The California Coastal Commission, therefore, is a source of information for developing a potential nonpoint source runoff abatement program or implementing best management practices (BMPs) to meet the goals of the state's plan in the Los Angeles urban and suburban areas. The Board may welcome direct support by SBPP toward implementing some of the BMPs as compensation for the impingement (and entrainment losses) at SBPP.

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Appendix B

Additional Biological Studies and Analysis

Table of Contents

1.0 Introduction

On July 9, 2004, the U.S. EPA published Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities. These Section 316(b) requirements went into effect in September 2004, and apply to existing generating stations with cooling water intake structures that withdraw at least 50 million gallons per day (mgd) from rivers, streams, lakes, reservoirs, oceans, estuaries, or other waters of the U.S. The cooling water intake flow at the SBPP exceeds 50 mgd and the plant is, therefore, subject to the new rule.

As part of the Section 316(b) Comprehensive Demonstration Study (CDS) required under the new regulations, a facility may be required to submit an Impingement Mortality and Entrainment (IM&E) Characterization Study depending on the chosen compliance pathway. The Impingement Mortality component is not required if a facility's through-screen intake velocity is less than or equal to 0.5 ft/s (15 cm/s). Based on previously collected intake velocity measurements, the through-screen intake velocity at the SBPP exceeds this value. The Entrainment Characterization component is not required if a facility: (a) has a capacity utilization rate of less than 15%; (b) withdraws cooling water from a lake or reservoir, excluding the Great Lakes; or (c) withdraws less than 5% of the mean annual flow of a freshwater river or stream. SBPP Unit 4 qualifies for exemption from IM&E performance reduction standard, therefore, both the Impingement Mortality and Entrainment components of the Assessment will only apply to SBPP Units 1, 2, and 3.

According to the Section 316(b) Phase II Regulations, the Impingement Mortality and Entrainment Characterization Study must include the following (for all applicable components):

- Taxonomic identifications of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) that are in the vicinity of the cooling water intake structure(s) and are susceptible to impingement and entrainment;
- A characterization of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) identified in the taxonomic identification noted previously, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structure(s), based on sufficient data to characterize the annual, seasonal, and diel variations in the impingement mortality and entrainment; and
- Documentation of current impingement mortality and entrainment of all life stages of fish, shellfish, and any protected species identified previously and an estimate of impingement mortality and entrainment to be used as the calculation baseline.

Duke submitted the results of their completed IM&E of the SBPP CWIS to the Board in April 2004. These studies, which were ordered by the Board to update the facility's previous 316(b) studies, characterize the impingement and entrainment effects from operations of the SBPP CWIS on the facility's source water fishes and shellfish. The Section 316(b) Final Regulations allow "historical data that are representative of the current operation of your facility and of biological conditions at the site" to be used in the characterization. The SBPP 316(b) studies, of the facility's impingement and entrainment effects, which were ordered by the Board and completed in 2003, updated the facility's previous 316(b) studies and are in full compliance with the EPA's requirement for contemporary information on impingement mortality and entrainment of the SBPP CWIS. The study design, interim results, and final report were reviewed and approved through peer review in routine meetings attended by scientists and representative of the involved regulatory and resource agencies.

While no other IM&E studies are planned, in order to complete the facility's CDS, an impingement survival study, as described in this Appendix, is proposed to assess the presently unquantified benefits of SBPP's CWIS fish return system. The IM&E data collected in the 2001-2003 studies, as reported to the RWQCB and made a part of the facility's renewed NPDES permit, will be reanalyzed, as also described in this Appendix. This reanalysis will be based on the average of actual intake flows for the past five years rather than intake flows based on 100% operations (24 hours per day, 7 days per week) of all four units at pump manufacturers' design flows that were used in the 2004 316(b) Resource Assessment. The reanalysis of entrainment and impingement mortality will also exclude the intake flow of Unit 4 since its average capacity factor was less than 15%.

2.0 Power Plant Cooling Water System Assessment: Reanalysis of 2004 316(b) Assessment

Power plant intake effects occur due to impingement of larger organisms onto the intake screens and entrainment of organisms into the CWIS that are smaller than the screen mesh on the intake screens. For the purposes of our study we assumed that both processes lead to mortality of all impinged and entrained organisms. Considerable effort among regulatory agencies and the scientific community has been expended on the evaluation of power plant intake effects over the past three decades. The variety of approaches developed reflects the many differences in power plant locations and resource settings. MacCall et al. (1983), in their review of the various approaches, divided them into those that offer a judgment on the presence or absence of impact and those that describe the sensitivity of populations to varying operational conditions. These efforts have helped to establish the context for the modeling approaches that were employed in the 2004 analysis and assessment of SBPP entrainment and impingement mortality and will be the same methods employed to reanalyze the 2001–2003 IM&E data based SBPP actual intake flows (excluding Unit 4's flow) to estimate impingement and entrainment effects at the SBPP.

Impact assessment approaches that will be considered for this study include:

- adult-equivalent loss (*AEL*) (Horst 1975; Goodyear 1978),
- fecundity hindcasting (*FH*) proposed by Alec MacCall, NOAA/NMFS, which is related to the adult-equivalent loss approach, and
- empirical transport model (*ETM*), which is similar to the approach described by MacCall et al. (1983), and used by Parker and DeMartini (1989).

These approaches can be placed under the umbrella of two general approaches: demographic models that rely on species life history information such as the equivalent adult model (*EAM*; Horst 1975, Goodyear 1978) which includes adult equivalent loss (*AEL*) and fecundity-hindcasting (*FH*); and models that estimate the conditional mortality on a population resulting from power plant CWIS operations such as the empirical transport model (*ETM*; Boreman et al. 1978).

The application of several models to estimate power plant effects is not unique (Murdoch et al. 1989, PSE&G 1993, Tenera 2000a, Tenera 2000b). Equivalent adult modeling (*AEL* and *FH*) is an accepted method that has been used in other 316(b) demonstrations (PSE&G 1993, Tenera 2000a, Tenera 2000b) and will also be used, where appropriate data are available, at the SBPP. The advantage of these demographic modeling approaches is that they translate losses into adult fishes that are familiar units to resource managers. These estimates can be also combined with estimated losses to adult and juvenile organisms due to impingement to provide combined estimates of cooling water system effects.

The empirical transport model (*ETM*) is a method to estimate mortality rates from cooling water withdrawals at power plants that was proposed by the U.S. Fish and Wildlife Service (Boreman et al. 1978, 1981). Variations of this model were discussed in MacCall et al. (1983) and used to assess impacts at the San Onofre Nuclear Generating Station (Parker and DeMartini 1989). The *ETM* was also used to assess impacts at the Diablo Canyon Power Plant and Huntington Beach Generating Station in California (Tenera 2000a, MBC and Tenera 2005), and at the Salem Nuclear Generating Station in Delaware Bay, New Jersey (PSE&G 1993), as well as other power stations along the East Coast. Empirical transport modeling permits the estimation of conditional mortality due to entrainment while accounting for the spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The *ETM* provides an estimate of power plant effects that may be less subject to inter-annual variation than demographic model estimates. It also provides an estimate of population-level effects not provided by demographic approaches.

The results of the *ETM* modeling provide the best and most direct estimates of the effects of entrainment on source water populations since the effects are estimated on the larval populations being affected. The *ETM* estimates can be used to appropriately scale restoration projects that might be used to help offset entrainment losses. The estimates can also be used to provide a context for demographic model estimates that are based solely on entrainment estimates. For example, especially in estuarine systems, entrainment estimates may show large losses of fish larvae that are sometimes difficult to interpret and put in context without estimates of the adult or larval source water populations. The *ETM* provides a context for these estimates and if the results show that the effects on the source populations are relatively low can account for some of the uncertainty associated with determining what level of entrainment reduction might be appropriate.

The following sections provide details on our approaches for estimating cooling water system effects on marine organisms in the vicinity of the SBPP. Impingement effects will be re-assessed using data from intake sampling. Entrainment effects will be re-assessed using data from cooling-water intake and source water sampling using all three modeling approaches where appropriate for a taxon. The results of the *FH* and *AEL* impingement and entrainment re-assessments will be combined for taxa when possible.

2.1 Selection of Target Taxa

2.1.1 Impingement Target Taxa

Estimates of annual impingement will be recalculated for all the target organisms. Re-assessment of CWIS impingement effects will only be calculated for the most abundant organisms in the samples, as was the case for the 2004 316(b) report (Tenera Environmental 2004). The re-assessment may also include other commercially or recreationally important taxa from the samples. All fishes and macroinvertebrates were collected and identified from impingement samples, but the following groups of marine organisms were enumerated, weighed, and measured in the 2002–2003 studies.

- **Vertebrates:**

  fishes

- **Invertebrates:**

  crabs, squid, shrimps, octopus, California spiny lobster

2.1.2 Entrainment Target Taxa

Estimates of annual entrainment will be re-calculated for all the target organisms. Re-assessment of CWIS entrainment effects will only be conducted on the most abundant organisms in the samples, and commercially or recreationally important taxa from entrainment samples, as was the case for the 2004 316(b) report. The following groups of marine organisms were sorted, identified, and enumerated from entrainment intake and source water plankton samples:

- **Vertebrates:**

  fishes (all life stages beyond egg)

- **Invertebrates:**

  rock crab megalopal larvae (*Cancer* spp.), market squid hatchlings [larvae] (*Loligo opalescens*), and California spiny lobster phyllosoma larvae (*Panulirus interruptus*)

Fishes and rock crab larvae were selected because of their respective ecological roles or commercial and/or recreational fisheries importance. Market squid and California spiny lobster were selected because of their commercial and/or recreational importance in the area. All the target organism groups (fishes, rock crabs, squid, and lobster) were counted and identified to the lowest taxonomic level possible.

The specific taxa (species or group of species) that will be re-analyzed will be limited to the taxa that were sufficiently abundant to provide a reasonable assessment of impacts. For the purposes of this re-assessment, the target taxa analyzed will be limited to the most abundant taxa that together comprised 90–95% of all larvae entrained and/or juveniles and adults impinged by the power plant. As was the case for the 2004 316(b) report, the most abundant taxa will be used in the re-assessment because they provide the most robust and reliable estimates of CWIS effects.

The power plant also entrains numerous other non-target planktonic and larval life forms that were not specifically included in the 2001–2003 study. These other non-target groups, including the larvae of other shellfish (crabs, clams, abalone, etc.), were not included because they are smaller than the larvae from the target organism groups and would have required separate sampling efforts and equipment to collect. In addition, the identification of many of these other non-target larvae to the species level is problematic and would likely have lead to uncertainty in the estimates of their abundance. The *ETM* model provides a means of examining the potential effects on these other non-target organisms by assuming that they are uniformly distributed in the source water area and are withdrawn at a rate equal to the volumetric ratio of the cooling water flow to the source water volume. The effect of entrainment on these organisms also depends on their larval duration or the time period they are exposed to entrainment. The relationship between larval duration and currents that determine the volume of the source water will be used to estimate effects at various larval durations.

Fish eggs were not sorted or identified because a full assessment of their abundance would have also required different sampling techniques and, as with the non-target species, they also cannot be identified to the same taxonomic levels as fish larvae. Even though egg life stages were not quantified from the entrainment and source water samples, entrainment effects on fishes with planktonic egg stages will be accounted for in the *ETM* model by adding the time period that eggs are planktonic to the estimate of the time period that larvae of each species analyzed are at risk of entrainment. This approach assumes that the proportional mortality estimate used in the modeling of larval entrainment also applies to egg mortality and that for both egg and larval stages, mortality on passage through the cooling system is 100%.

2.2 Estimating Entrainment Effects

Estimates of daily and annual larval entrainment at SBPP will be re-calculated from data collected at the entrainment station from January 2001–January 2002, and December 2002–December 2003. Estimates of entrainment loss, in conjunction with demographic data collected from the fisheries literature, permit modeling of adult equivalent loss (*AEL*) and fecundity hindcasting (*FH*). Data from sampling of the potential source populations of larvae will be used to re-calculate estimates of proportional entrainment (*PE*) that are used to estimate the probability of mortality due to entrainment using the Empirical Transport Model (*ETM*). In the re-analysis of the SBPP entrainment and impingement studies we will use each approach (i.e., *AEL*, *FH*, and *ETM*) as appropriate for each target taxon to assess effects of power plant losses.

2.2.1 Demographic Approaches

Adult equivalent loss (*AEL*) models evolved from impact assessments that compared power plant losses to commercial fisheries harvests and/or estimates of the abundance of adults. In the case of adult fishes impinged by intake screens, the comparison was relatively straightforward. To compare the numbers of impinged sub-adults and juveniles and entrained larval fishes to adults, it was necessary to convert all these losses to adult equivalents. Horst (1975) provided an early example of the equivalent adult model (*EAM*) to convert numbers of entrained early life stages of fishes to their hypothetical adult equivalency. Goodyear (1978) extended the method to include the extrapolation of impinged juvenile losses to equivalent adults.

Demographic approaches, exemplified by the *EAM*, produce an absolute measure of loss beginning with simple numerical inventories of entrained or impinged individuals and increasing in complexity when the inventory results are extrapolated to estimate numbers of adult fishes or biomass. We will use two different but related demographic approaches in re-assessing entrainment effects at the SBPP: *AEL*, which expresses effects as absolute losses of numbers of adults, and *FH*, which estimates the number of adult females whose reproductive output has been effectively eliminated by entrainment of larvae. Both estimates require an estimate of the age at entrainment. These estimates were obtained by measuring a random sample of up to 200 larvae of each of the target taxa from the entrainment samples and using published larval growth rates to estimate the age at entrainment. The age at entrainment was calculated by dividing the difference between the size at hatching and the average size of the larvae from entrainment by a growth rate obtained from the literature.

Age-specific survival and fecundity rates are required for *AEL* and *FH*. Adult-equivalent loss estimates require survivorship estimates from the age at entrainment to adult recruitment; *FH* requires egg and larval survivorship until entrainment. Furthermore, to make estimation practical, the affected population is assumed to be stable and stationary, and age-specific survival and fecundity rates are assumed to be constant over time. Each of these approaches provides estimates of adult fish loss, which will still need to be placed into context regarding standing stocks of adult fishes.

Species-specific survivorship information (e.g., age-specific mortality) from egg or larvae to adulthood is limited for many of the taxa considered in this re-assessment. Thus, in many cases, these rates had to be inferred from the literature along with their measures of uncertainty. Uncertainty surrounding published demographic parameters is seldom known and rarely reported, but the likelihood that it is very large should be considered when interpreting results from the demographic approaches for estimating entrainment effects. For some well-studied species (e.g., northern anchovy), portions of early mortality schedules and fecundity have been reported (e.g., Parker 1980; Zweifel and Smith 1981; Hewitt 1982; Hewitt and Methot 1982; Hewitt and Brewer 1983; Lo 1983, 1985, and 1986; McGurk 1986). Because the accuracy of the estimated entrainment effects from *AEL* and *FH* will depend on the accuracy of age-specific mortality and fecundity estimates, lack of demographic information may limit the utility of these approaches.

The precursor to the *AEL* and *FH* calculations is an estimate of total annual larval entrainment. Estimates of larval entrainment at the SBPP will be based on the monthly sampling where $\widehat{E}_T$ is the estimate of total entrainment and $\widehat{E}_i$ is the monthly entrainment estimate. Estimates of total entrainment are based on two-stage sampling designs, with days within each sampling period and cycles within days. The within-day sampling is based on a stratified random sampling scheme with four temporal cycles and two replicates per cycle.

2.2.2.1 Adult Equivalent Loss (AEL)

The *AEL* approach uses estimates of the abundance of the entrained or impinged organisms to project the loss of equivalent numbers of adults based on mortality schedules and age-at-recruitment. The primary advantage of this approach is that it translates power plant-induced early life-stage mortality into numbers of adult fishes that are familiar units to resource managers. Adult equivalent loss does not require source water estimates of larval abundance in assessing effects. This latter advantage may be offset by the need to gather age-specific mortality rates to predict adult losses and the need for information on the adult population of interest for estimating population-level effects (i.e., fractional losses).

Starting with the number of age class j larvae entrained, $\hat{E}_j$, it is conceptually easy to convert these numbers to an equivalent number of adults lost $\widehat{AEL}$ at some specified age class from the formula:

$$\widehat{AEL} = \sum_{j=1}^{n} \hat{E}_j S_j \tag{1}$$

where

n = number of age classes;

$\hat{E}_j$ = estimated number of larvae lost in age class j; and

S_j = survival probability for the jth class to adulthood (Goodyear 1978).

Age-specific survival rates from larval stage to recruitment into the fishery must be included in this assessment method. For some commercial species, natural survival rates are known after the fish recruit into the commercial fishery. For the earlier years of development, this information is not well known and may not exist for non-commercial species.

An alternative expression of adult-equivalent loss would be to standardize $\widehat{AEL}$ by the size of the adult population of interest to estimate the relative magnitude of the equivalent adult loss such that,

$$\widehat{RAEL} = \frac{\widehat{AEL}}{\hat{P}}, \tag{2}$$

where $\widehat{P}$ = estimated size of the adult population of interest. Information on adult source populations will be limited for many species and thereby limit the utility of Equation (2), although the same approach will be used to place the estimated losses into context for taxa with published commercial or recreational fishery catch data.

2.2.2.2 Fecundity Hindcasting (FH)

The *FH* approach compares larval entrainment losses with adult fecundity to estimate the amount of adult female reproductive output eliminated by entrainment, hindcasting the numbers of adult females effectively removed from the reproductively active population. The accuracy of *FH* estimates, as with those of the *AEL* above, is dependent upon accurate estimates of age-specific mortality from the egg and early larval stages to entrainment and accurate estimates of the total lifetime female fecundity. If it can be assumed that the adult population has been stable at some current level of exploitation and that the male:female ratio is constant and 50:50, then fecundity and mortality are integrated into an estimate of loss by converting entrained larvae back into females (i.e., hindcasting).

A potential advantage of *FH* is that survivorship need only be estimated for a relatively short period of the larval stage (i.e., egg to larval entrainment). The method requires age-specific mortality rates and fecundities to estimate entrainment effects and some knowledge of the abundance of adults to assess the fractional losses these effects represent. This method assumes that the loss of a single female's reproductive potential is equivalent to the loss of an adult fish.

In the *FH* approach, the total of larval entrainment for a species $\widehat{E}_T$ will be projected backward to estimate the number of breeding females required to provide the numbers of larvae entrained at SBPP. The estimated number of breeding females $\widehat{FH}$ whose fecundity is equal to the total loss of entrained larvae would be calculated as follows:

$$\widehat{FH} = \frac{\widehat{E_T}}{\widehat{TLF} \bullet \prod_{j=1}^{n} S_j} \qquad (3)$$

where

$\widehat{E}_T$ = total entrainment estimate;

S_j = survival rate from eggs to entrained larvae of the j th stage ;

$\widehat{TLF}$ = average total lifetime fecundity for females, equivalent to the average number of eggs spawned per female over their reproductive years.

The two key input parameters in Equation (3) are total lifetime fecundity $\widehat{TLF}$ and very early survival rates S_j from spawning to entrainment. Descriptions of these parameters may be limited for many species and are a possible limitation of the method.

An alternative interpretation of *FH* is possible by expressing the estimate in terms of the relative size of the adult fish stock in the source populations where

$$\widehat{RFH} = \frac{\widehat{FH}}{\widehat{P}} \tag{4}$$

where $\widehat{P}$ = estimated size of the adult population of interest. Information on adult source populations will be limited for many species and thereby limit the utility of Equation (4), although the same approach can be used to place the estimated losses into context for taxa with published commercial or recreational fishery catch data where $\widehat{RFH}$ is the proportion of the breeding females whose fecundity was lost due to entrainment by SBPP.

2.2.2.3 Empirical Transport Model (ETM)

The *ETM* calculations provide an estimate of the probability of mortality due to power plant entrainment. The calculations require not only the abundance of larvae entrained but also the abundance of the larval populations at risk of entrainment. Sampling at the cooling water intake from January 2001–January 2002 and from December 2002–October 2003 will be used to re-estimate the total number of larvae entrainment for a given time period, while sampling in the coastal waters around the SBPP intake will be used to estimate the source population for the same period.

On any one sampling day, the conditional entrainment mortality can be expressed as

$$PE_i = \frac{\widehat{E_i}}{\widehat{R_i}} \tag{5}$$

where

E_i = total numbers of larvae entrained during the i th survey; and

R_i = numbers of larvae at risk of entrainment, i.e., abundance of larvae in source water.

The values used in re-calculating *PE* will be population estimates based on the respective concentrations and volumes of the cooling water system flow (the average actual flow for the past 5-year period, excluding flows from Unit 4) and source water areas. The abundance of larvae at risk in the source water during the i th survey can be directly expressed as

$$\widehat{R_i} = V_S \cdot \widehat{\overline{\rho}_{S_i}} \tag{6}$$

where V_S denotes the static volume of the source water (S_i), and $\widehat{\overline{\rho}}$ denotes an estimate of the average density in the source water.

Regardless of whether the species has a single spawning period per year or multiple overlapping spawnings the estimate of total larval entrainment mortality can be expressed by

$$\widehat{P_M} = 1 - \sum_{i=1}^{N} \widehat{f_i} \left(1 - \widehat{PE_i}\right)^q \tag{7}$$

where

q = number of days that the eggs and larvae are susceptible to entrainment, and

$\hat{f}_i$ = estimated annual fraction of total larvae hatched during the i th survey period.

To establish independent survey re-estimates, it will be assumed that during each survey a new and distinct cohort of larvae is subject to entrainment. Each of the monthly surveys will be weighted by $\hat{f}_i$ and estimated as the proportion of the total source population present during the i th survey period.

As shown in Equations 5 and 6 the estimates of *PE* are based on population estimates of specific volumes of water. While a reasonably accurate estimate of the volume of the cooling water intake flow can be obtained, estimating the volume of the source water is more difficult and varies depending upon oceanographic conditions and target taxon. The maximum age at entrainment was calculated using the lengths of a random sample of up to 200 larvae from the entrainment samples for each target taxon (Tenera 2004). The maximum age was calculated based on the upper 95th percentile value of the lengths measured from the samples. The maximum age at entrainment was calculated by dividing the difference between the upper 95th percentile value of the lengths measured from the samples minus the hatch length by the growth rate.

3.0 Fish Return System Assessment

The proposed studies will examine the survival of fish removed from the traveling screens by a low-pressure system and returned to the SBPP source water.

3.1 Fish Return Sampling

Duke plans to conduct a study to determine the effectiveness of the existing fish return system. A mesh-lined collection device will be used to collect samples from the diverted flow of the fish return system. Samples will be collected over a 24-hour period during times when previous studies determined high abundances of fishes or selected macroinvertebrates. All fishes and selected macroinvertebrates (crabs, shrimps, lobster, octopus and squid), hereafter referred to as "target organisms," will be removed from the collection devices and their condition (alive or dead) will be determined. All live target organisms will be placed into numbered collection chambers in an aquarium so that their condition can be monitored and recorded for a period of up to two hours after collection. All "initial" dead target organisms will be identified in the field if possible, or preserved in ethanol and placed into labeled containers. The condition of the live target organisms will be monitored approximately every 30 minutes throughout the 2-hour monitoring process. Dead organisms will be removed and identified if possible, or preserved, and labeled for identification in the laboratory. At the end of the 2-hour monitoring period, any remaining live organisms that can be identified will be measured and released, and any target organisms that cannot be identified will be preserved and placed in a labeled container and returned to the laboratory for identification. All target organisms will be identified to the lowest taxonomic level practical.

The total counts of each species/taxa and the volume of water will be combined for each survey. Mean concentrations, identified to the lowest taxonomic level practical, first will be computed by dividing the number of each taxon or species in each survey by the survey volume. The percent survival for each fish return system survey will be calculated based on the number of live organisms divided by total number of target organisms (both live and dead combined). To calculate the overall average survival rate, the total number of live fishes and target macroinvertebrates for all surveys combined will divided by the total number of fishes and target macroinvertebrates (both live and dead) for all surveys combined.

Depending on the number of individuals of a given target species present in the sample, one of two specific procedures will be used, as described below. Each of these procedures involves the following measurements and observations:

1. The appropriate linear measurement for individual fishes and motile invertebrates will be determined and recorded. These measurements will be recorded to the nearest

1 mm. The following standard linear measurements will be used for the animal groups indicated:

- Fishes – Total body length for sharks and rays and standard lengths for bony fishes.
- Crabs – Maximum carapace width.
- Shrimps & Lobsters – Carapace length, measured from the anterior margin of carapace between the eyes to the posterior margin of the carapace.
- Octopus – Maximum "tentacle" spread, measured from the tip of one tentacle to the tip of the opposite tentacle.
- Squid – Dorsal mantle length, measured from the edge of the mantle to the posterior end of the body.

2. The wet body weight of individual animals will be determined after shaking loose water from the body. Total weight of all individuals combined will be determined in the same manner. All weights will be recorded to the nearest 0.035 ounce (1 g).

3. The qualitative body condition of individual fishes and macroinvertebrates will be determined and recorded, using codes for decomposition and physical damage.

4. Other non-target, sessile macroinvertebrates will be identified to species and their presence recorded, but they are not measured or weighed. Rare occurrences of other returned animals, such as dead marine birds, will be recorded.

5. The amount and type of debris (e.g., *Mytilus* shell fragments, wood fragments, etc.) and any unusual operating conditions in the screen well system will be noted by writing specific comments in the "Notes" section of the data sheet.

The following specific procedures will be used for processing fishes and target invertebrates when the number of individuals per species in the sample or subsample is < 30:

- For each individual of a given species the linear measurement, weight, and body condition codes will be determined and recorded on separate lines.

The following specific subsampling procedures will be used for fishes and target invertebrates when the number of individuals per species is >30:

- The linear measurement, individual weight, and body condition codes for a subsample of 30 individuals will be recorded individually on the data sheet. The individuals selected for measurement will be selected after spreading out all of the individuals in a sorting container, making sure that they are well mixed and not segregated into size groups. Individuals with missing heads or other major body parts will be eliminated from consideration, since their linear measurements would not be representative.
- The total number and total weight of all the remaining individuals combined will be determined and recorded separately.

4.0 Quality Control Program

A quality control (QC) program will be implemented to ensure that all of the target organisms are removed from the debris and that the correct identification, enumeration, length and weight measurements of the organisms will be recorded on the data sheet. Random samples will be chosen for QC re-sorting to verify that all the collected organisms were removed from the samples. Quality control surveys will be done on a quarterly or more frequent basis if necessary during the study.

5.0 Larval and Cooling Water Re-Entrainment Study

Any recirculation of SBPP cooling water flows from the discharge channel back into the intake channel represents re-entrainment of organisms already counted in the assumption of 100% entrainment mortality. Therefore, these recirculated flows can be subtracted from the intake flows used in the re-analysis of Units 1, 2, and 3 entrainment effects. Earlier recirculation studies of the SBPP cooling water intake and discharge flows indicated a detectable level of recirculation of discharged cooling water flow (Lockheed 1983). The investigators' methods suggest that additional temperature of the discharge flow is directed toward the intake, but their findings also contained uncertainty, as other factors such as wind and solar radiation were not included. Recent studies by Tenera and Merkel (2004) showed that heated effluent from the discharge was directed toward the intake under certain tidal and plant operational conditions. Because temperature is a non-conservative measure, the amount of recirculation could be greater than these studies results indicate.

Duke proposes to conduct a two-phase re-entrainment study that will consist of 1) modeling of particle circulation probability, and 2) source water tracer-dye sampling, contingent on the results of phase one. Analytical approaches for estimating re-entrainment effects are also presented. A model, TRIM2D, is based on a numerical hydrodynamic model constructed and calibrated for San Diego Bay (Wang et al. 1998). The model is structured on the depth-averaged tidal and residual circulation model known as TRIM-2D (Cheng et al. 1993) with modifications made to improve model stability and accuracy (Casulli and Cattani 1994).

5.1 Cooling-Water Intake System Entrainment Modeling

An informative and cost effective method for assessing bay and estuarine transport processes is through the use of computer modeling. TRIM2D (see model description which follows) has been used successfully to model several processes in the San Diego Bay. It is well suited for examination and quantification of hydrodynamic transport processes related to the SBPP including evaluation of any recirculation of SBPP CWIS water (i.e., quantification of power plant inflow water that has previously been part of the outflow).

The primary dynamic factors affecting SBPP recirculation are the inflow/outflow rates and the bay's tidal conditions. The model is capable of marking plant outflow and monitoring its transport. For a given steady inflow/outflow rate, model simulations can be run over several spring/neap tidal cycles and used to quantify the steady state recirculation that is occurring. This recirculation will most likely be influenced by tidal history. Model outputs can include time and tidal dependent plots of the percentage of recirculated inflow along with movie visualizations of the transport.

A further constraint of interest on recirculation is the elapsed time since outflow. For instance, assuming larvae are susceptible for a limited time (e.g., 10 days) in open water, it is of interest to quantify how much recirculation occurs. In addition, larval concentrations may diminish not only through dispersion but also from predation. These conditions can be simulated using the model.

TRIM2D is a two-dimensional (i.e., depth-averaged) numerical model designed for use in shallow, intertidal settings such as San Diego Bay. The model was developed by Cheng, Casulli and Gartner and has been used successfully Dr. Ralph Cheng for San Francisco Bay circulation and by Dr. Don Sutton for the San Diego Bay circulation (Helly et al. 2001) at the San Diego Supercomputer Center over the course of the past 15 years. The application to San Diego Bay has been validated with an extensive suite of field data and simulations produce output that is well matched to field measurements (Wang et al.1998). Some of these results for San Diego Bay can be found at http://sdbay.sdsc.edu.

In shallow embayments and estuaries in arid climatic conditions such as San Diego Bay, the vertical mixing is usually complete to the point that there is little or no vertical stratification. However, there can be important horizontal gradients in salinity or pollutants as the result of mixing of watershed inputs and ocean water driven by the tidal cycle. It is, therefore, important to accurately resolve horizontal gradients, and of less importance to resolve the vertical structure of the circulation. TRIM2D is well suited to this type of problem.

TRIM2D uses a semi-implicit, finite-difference method to solve the shallow water equations. A rather complete technical description of TRIM2D can be found in (Cheng et al. 1993) and a more general discussion of the shallow-water equations in (Gill 1982) while the San Diego Bay adaptations and calibrations for hydrodynamic components have been previously presented in Wang et al. (1998). The TRIM2D model is numerically unconditionally stable as a result of a unique approach to combining the convective terms (Euler-Lagrangian) with an implicit, finite-difference treatment of the water surface elevation in the momentum equations and the velocity divergence in the continuity equations. The remaining terms are finite-differenced explicitly. This makes it computationally efficient and reliable at fine spatial scales. The TRIM2D model output is based on a computational mesh of 92,272 grid nodes equidistant from each other on 15 m spacing covering the southern portion of the San Diego Bay. The boundary for the model wetted field is set by the shoreline interface (+3 ft MLLW) throughout the south San Diego Bay limited by a east-west transect at about 32º 38.5’ Latitude.

5.2 Source Water Transport and Recirculation Sampling

The use of TRIM2D requires particular types of data to enable it to be properly configured, executed, and calibrated. These include an accurate rectangular bathymetric grid that represents the bottom of San Diego Bay at a spatial resolution on the order of tens of meters, as well as data on tidally-driven surface water elevation and water currents by time and location. These data are essential for the calibration of TRIM2D as well as for the verification of predictions that are based on its execution. Field data collection is expensive and time consuming. Obtaining baywide bathymetry data at a fine resolution is important for the accuracy and precision of the model predictions. For water surface and water current measurements, data collection at a relatively few strategic locations is adequate. For San Diego bay these data have been collected and the model has been validated.

Bathymetric data for the model was derived from National Oceanographic and Atmospheric Administration (NOAA) navigational data for San Diego Bay approach areas. Bay bathymetry is derived from U.S. Navy, Southwest Division, Nat. Resources 1993 field surveys (U.S. Navy 1994). For the South Bay region of interest in this investigation, a more recent and refined resolution bathymetric data set was created for using data collected by Merkel & Associates, Inc. and Tenera Environmental.

Each run of the model produces a time-series of the bathymetric grid with values of water elevation, velocity at the grid points. TRIM2D can also produce similar gridded outputs for transported substances that are effectively diluted by advection and diffusion such as storm drain or creek outfall pollutants. These data are combined into quantitative analyses. The model output enables various types of visualizations such as time series plots and gridwide maps and animations to be generated.

A tracer-dye study can provide confidence in the model analyses. An investigation will be made to determine the need, contingent upon the modeling effort. Tracer-dye studies, simply explained, are studies which involve injecting a dye at some location in the water body and measuring the resulting response, or dye cloud, at other locations downstream to determine the time of travel and the dispersion characteristics of the stream. Turner Designs gives guidelines for constructing tracer dye studies using a fluorometer in a monograph “Circulation, Dispersion and Plume Studies.”

6.0 Reporting

Tenera Environmental will produce a final report on the findings reanalysis of the entrainment and impingement studies, the fish return study, and the re-circulation study. Results from field surveys will be presented, and loss estimates derived from one or more of the assessment methods will be presented for each of the selected target taxa. The report will be submitted as part of the Comprehensive Demonstration Study for the SBPP.

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Duke Energy South Bay LLC

316(b) Proposal for Information Collection for South Bay (San Diego) Power Plant

Appendix C

Deriving Economic Benefits of Reduced Impingement and Entrainment at Duke's South Bay Power Plant

Proposal for Information Collection (PIC): Deriving Economic Benefits of Reduced Impingement and Entrainment at Duke's South Bay Power Plant

Background

For use of the Cost-Benefit test under the site-specific standards, Duke Energy is required to have a Benefits Valuation Study prepared. The final 316(b) Phase II Final Rule (herein after referred to as the Rule) requires use of a comprehensive methodology to value fully the impacts of impingement and entrainment mortality at the South Bay Power Plant (SBPP). Other requirements for use of the test include:

- A description of the methodology(ies) used to value commercial, recreational, and ecological benefits (including non-use benefits, if applicable);

- Documentation of the basis for any assumptions and quantitative estimates. If the valuation includes use of an entrainment survival rate other than zero, a determination of entrainment survival at the facility based on a study approved by the NPDES permitting authority must be submitted;

- An analysis of the effects of significant sources of uncertainty on the results of the study;

- If requested by the NPDES permitting authority, a peer review of the items you submit in the Benefits Valuation Study. You must choose the peer reviewers in consultation with the Director who may consult with EPA and Federal, State, and Tribal fish and wildlife management agencies with responsibility for fish and wildlife potentially affected by your cooling water intake structure. Peer reviewers must have appropriate qualifications depending upon the materials to be reviewed.

- A narrative description of any non-monetized benefits that would be realized at your site if you were to meet the applicable performance standards and a qualitative assessment of their magnitude and significance.

All benefits, whether expressed qualitatively or quantitatively, should be addressed in the Benefits Valuation Study and considered by the NPDES permitting authority and in determining whether compliance costs significantly exceed benefits.

The benefits assessment begins with an impingement mortality and entrainment (IM&E) study that quantifies both the baseline mortality as well as the expected change from rule compliance.

Based on the information generated by the IM&E studies, the benefits assessment includes a qualitative and/or quantitative description of the benefits that would be produced by compliance with the applicable performance standards at the facility site. To the extent feasible, dollar estimates of all significant benefits categories would be made using well-established and generally accepted valuation methodologies.

In order to have the appropriate information if the benefit/cost option is chosen, we propose a strategy for the collection and analysis of economic information. It should be noted that one particular benefit category, benefits accruing to individuals even if they have no plans ever to use resources associated with SBPP (non-use benefits), are to be estimated only …"(i)n cases where the impingement or entrainment study identifies substantial harm to a threatened or endangered species, to the sustainability of populations of important species of fish, shellfish or wildlife, or to the maintenance of community structure and function in a facility's water body or watershed." (Final Rule, Federal Register page 41648).

"Substantial harm" is a stringent requirement to necessitate estimation of non-use values and thus non-use values usually would not be included in the final analysis. However, because the Final Rule does raise the potential for estimation of non-use values, we do provide some contingency for their estimation.

Description of Methodologies to Determine Benefits

The 316(b) rule defines a performance standard that the EPA has established for all existing power plant facilities to meet. The SBPP station is located on San Diego Bay and therefore it is subject to the impingement mortality (IM) performance standard (requiring a reduction in IM of 80% to 95%) and the entrainment (E) reduction performance standard (requiring a reduction in E of 60% to 90%). However, the Final Rule states that facilities do not have to meet the IM and E performance standard if it can be shown that the costs of achieving the performance standard are significantly greater than the benefits. Therefore we are providing a plan to collect information in case it is necessary to determine whether the benefits of the identified technology are significantly less than costs.

The previous operators of the SBPP (San Diego Gas and Electric Company) conducted IM&E sampling at SBPP from February 1979 through January 1980. Two additional years of entrainment and source water sampling were conducted by Duke Energy at nine stations in south San Diego Bay monthly from January 2001 through January 2002 and bi-monthly from December 2002 through October 2003. Impingement sampling was conducted weekly from December 2002 through December 2003. Updated impingement and entrainment monitoring studies at SBPP were completed in 2004. Gobies (comprised of arrow, cheekspot, and shadow gobies) and anchovies (comprised of bay and deepbody anchovies), comprised greater than 95 percent of the total estimated entrained larvae for both sampling periods. California halibut, white seabass, and other commercial or recreational fishery species comprised less than

0.1 percent of the total estimated entrained larvae during both sampling periods. Anchovies (mainly juvenile slough anchovy) were more abundant in the recent impingement study than the earlier study whereas round stingray, specklefin midshipman, diamond turbot, California halibut, and Pacific butterfish were less abundant. When the complete impingement and entrainment assessment is done, we will know which species are directly or indirectly (through forage fish changes) affected. For now, we consider the typical recreational and commercial species that are caught in and around South San Diego Bay. When better information is available, more specification will be possible and be made. It is possible although highly unlikely, that non-use values will need to be addressed.

The EPA examined a technology (closed-cycle cooling) to achieve a national standard for entrainment and impingement mortality. In determining benefits at a national level, EPA used certain economic concepts of benefits associated with using the assets that cooling water adversely effects and methodologies to estimate the benefits (U.S. EPA, 2004a; U.S. EPA 2004b; U.S. EPA 2004c). In order to make the benefits comparable to costs, they presented benefits in a monetary unit, dollars. Their benefit estimates reflected the willingness to pay of individuals to go from the current environmental status to one associated with an identified technology. All of the methods proposed in this PIC were also used in EPA's national analysis.

More specifically, this benefit analysis will seek to provide a unit value per fish caught ($/fish) for recreational and commercial species affected by the new technology. With this information, total recreational and commercial benefits can be determined by multiplying the unit value times the expected increase in recreational and commercial catch arising from the identified technology. In addition, some information will be provided with respect to non-use values.

Recreational Angling

For the recreational anglers, there are two potential ways to proceed:

- Benefit Transfer- the application of benefit estimates provided in other studies to the SBPP situation;

- Primary research- collection and/or assemblage of data on recreational fishing in the Southern California area and using the data to derive an estimate of the value per fish for the important species.

While the two approaches initially will be discussed independently, there is a sound reason to consider them in concert with one another. That is, the benefit transfer information provides a reality check for any values derived in the primary research. Any primary research effort should contain a thorough literature review, a component that would have information very similar in nature to the benefits transfer analysis. Also, the benefit transfer approach may provide a fallback position if the primary research is unsuccessful in providing benefit estimates. After both have been discussed independently, a strategy that integrates them will be offered.

A Benefit Transfer Approach

The use of benefit transfers requires finding a previous economic study (or studies) that considers a comparable situation to fishing near the SBPP and contains dollar values per unit fish caught or a value function for dollar values per unit fish caught. Particularly important would be having species similar to the effected species and a fishing population similar to the SBPP situation. Although there are numerous other aspects of the fishing situation that might be important, these two are the most critical.

In order to identify an appropriate study or studies, it would be essential to visit the site to examine first-hand the type of recreational fishing that is occurring. At the same time, contact with key people in the area will be made to determine if any relevant studies do exist (see references for some articles). We would consider it essential that the following sources be contacted or examined:

1) State or Federal Hearings on previous SBPP station's license renewal.
2) State or Federal Hearings on previous power plant facilities in the general southern California area.
3) Authors of EPA "in-house" studies associated with the Final Rule. In particular, EPA's RUM analysis of the California region (U. S. EPA. 2004d) should be considered.
4) Personnel from the National Marine Fisheries Service in La Jolla and California Fish and Game.
5) Key Informants at universities or other research facilities
   a) *University of California, San Diego*
      Dr. Richard Carson (Department of Economics) is an expert in contingent valuation
   b) *University of California, Berkeley*
      Dr. Michael Hanneman (Department of Agricultural and Resource Economics) is an expert in economic valuation and has studied sportfishing in southern California
   c) *University of California, Los Angeles*
      Dr. Trudy Cameron is an expert in econometrics and has studied sportfishing in California.
   d) *Southwest Fisheries Science Center, National Marine Fisheries Service*
      Drs. Dale Squires and Sam Herrick are experts in fisheries economics and management.
   e) *Local Consulting firms*
      e.g. Jones and Stokes Inc. (particularly Mr. Thomas Wegge) of Sacramento has completed numerous sportfishing studies in California.
6) Existing bibliography sources available by internet

a) National Marine Fisheries Service, Southeast Fisheries Center
b) Sportfishing Values Database
c) Environmental Valuation Reference Inventory (EVRI): Canadian based.
d) Beneficial Use Values Database (BUVD)
e) Regulatory Economic Analysis Inventory, (REAI) maintained by the U.S. EPA
f) ENVALUE, an environmental value database maintained in Australia.

7) Investigation and Valuation of Fish Kills (American Fisheries Society, 1992) Excerpt: “Chapter 4 ("Monetary and Economic Valuation of Fish Kills") dates back to the Pollution Committee's Monetary Values of Fish booklets of 1970 and 1975, which dealt with southern U.S. species. In 1978, the AFS North Central Division's Monetary Values of Fish Committee published Reimbursement Values for Fish, addressing species in 12 northern states and 2 Canadian provinces. To integrate these and other regional values, a special AFS Monetary Values of Freshwater Fish Committee collected values from 135 federal, state, provincial, and private agencies and hatcheries. These data were published in 1982 as Part I of AFS Special Publication 13. For the present book, the Socioeconomics Section has repeated the earlier survey to update replacement costs for killed fish and summarized procedures for estimating the broader economic losses resulting from a fish kill.”

These potential sources will be used to obtain “off-the-shelf” values that could possibly be relevant to the effected species at the SBPP station. In addition, some of these contacts may be useful as researchers, data sources, and/or witnesses for any hearings that evolve. They may also be useful as peer reviewers or as sources to identify peer reviewers.

Primary Research

There are several other methodologies that could be used to obtain economic values for the species considered, but they will require some level of primary research.

Data and programs could be obtained from the U.S. EPA and examined to see if the results reported in USEPA (2004d) are defensible. If they are not, a new RUM model could be estimated with the data. The major changes introduced in the research would be to consider:

1) correcting (if necessary) problems associated with the original analysis;
2) creating groups of fish to designate the affected species rather than having them in an larger grouping;[25]

[25] For example, California halibut is considered in the category “bottomfish” in previous studies. If there were sufficient anglers targeting them, then a category “California halibut” could be designated.

3) specifying a narrower SBPP site rather that using the broad geographic sites used in the USEPA study. (Southern California counties were used as sites. The San Diego County site had 35 of the NMFS sites aggregated into it.)

The analysis would also update the angling activity and possible generalized the RUM model in ways that current research is including.

One of the major problems in the Southern California region is the potential for harvest of contaminated fish. California's Department of Health Services issues seafood consumption warnings and it will be necessary to consider the effect of seafood consumption advisories on the value of recreational fish. This was not done in the USEPA (2004d) study. While the San Diego Bay may not necessarily contain sites with seafood warnings, not including the effect of seafood warnings at other Southern California sites may bias the value estimates of recreational species.

Strategy to Obtain Recreational Unit Values per Fish Caught

The initial portion of the study would be to complete a benefits transfer analysis and determine whether or not the values obtained were reasonable for the purposes of the decisions to be made. That is, if the mitigation strategy returned recreational benefits that were approximately equal to the costs, it may be unwise and inefficient to move onto primary research because in all likelihood the estimate of costs would not be "significantly larger" than the benefits. If however, the benefit transfer method suggested that the benefits were to be small relative to costs, it may or may not be useful to do one of the primary research plans suggested in the previous section. The quality of existing studies would also be a determinant. Also, many re-licensing hearings associated with 316(b) regulations may have taken place and provide information/research tools that are useable for the SBPP situation.

Discussions with key informants in the benefit transfer work would determine the availability and reliability of data from the previous studies of recreational fishing. In addition, some notion of the potential improvement in estimates from using new data and a new model would be obtained.

With this information and a better understanding on the costs of doing the primary research studies, decisions regarding what combination of benefit transfer and primary research would be most advantageous. The primary research would in all likelihood provide better estimates of value but may be more costly. Given the present information, it is likely that the analysis performed by the U.S. EPA in 2004 could be used for an initial estimate of benefits. Additional effort would be devoted to determining whether the aggregation of sites and species as well as the neglect of seafood contamination warnings could cause the estimated values to be biased.

Commercial Fishing

The first determination would be whether commercial fishing is affected by reduced mortality to effected species. California Fish and Game and the National Marine Fisheries Service would be consulted regarding species that the impingement and entrainment studies identified. Both producers and consumers could gain from increases in commercial catch, but the assessment would likely only estimate the gains to direct producers, i.e. commercial fishermen. This is based on the expectation that relatively small changes in commercial landings result from reduced IM&E mortalities. This is the approach that EPA took in the 2004 study.

The approach that EPA uses for assessing commercial benefits to producers bases the unit value on the ex-vessel price (sometimes referred to as dockside price) of the species under consideration. The logic of the approach begins with an assumption that harvest increases do not induce effort (inputs used in harvesting) to increase in the short-run after the reductions of entrained and/or impinged organisms. If this were entirely true, then the ex-vessel price times the increase in quantity harvested would represent producers surplus. However, EPA appreciates that this would not likely be true and that effort and costs would undoubtedly increase in the long run in response to increased commercial profits (i.e. producer surplus). In the absence of property rights to the harvest, one would expect the producer surplus to be eliminated. Recognizing this and allowing for uncertainty in effort response, the EPA proposes using a range of 0–40% of the ex-vessel price times the increase in harvest as a measure of the increase in producers' surplus.

Additional economic information on coastal pelagic species (sardine, anchovy, squid and mackerel) and groundfish may be available through the fisheries management groups. For example, anchovy has been managed for some time (Huppert, 1981) and more recently a management plan for the small coastal pelagic species has been developed (Bargmann et al. 1998). These plans may contain information that would permit an analysis that is an improvement to the USEPA approach.

In the unlikely event that the change in landings would be relatively large and cause a change in commercial fisheries prices, we would need to collect information on commercial harvests and prices. There is not a good way to use benefit transfer methods for the consumers' surplus although EPA is exploring one proposed by Bishop and Holt (2003). This approach at present does not look that promising. At present, it does not appear that the change in commercial landings will be sufficiently large to cause prices changes.

However, if additional information suggests price changes, existing data from California Fish and Game and the National Marine Fisheries Service could be sufficient to estimate an inverse, general equilibrium demand curve (see Just, et al. for a description) for the species in question. With these estimates, the benefits to consumers could be calculated.

Non-use Valuation

Subsequent study by biologists will determine whether there is a necessity to assess non-use values. Based on current knowledge, it does not appear necessary to estimate them.

But, in the unlikely event that non-use values will have to be estimated, we would look to using a benefit transfer approach or doing primary research for SBPP. However, we do not believe that the magnitude of the non-use values would justify undertaking a primary research study for non-use values associated with SBPP.

Thus, if non-use values were needed, we would suggest using a benefit transfer method in all likelihood. There have not been any studies of non-use values associated with power plant activities per se. People have had to rely on studies associated with other types of activities. For example, EPA used a benefit transfers approach in their Proposal for the 316(b) regulations and in the NODA. EPA (Tudor et al., 2003) reviewed numerous studies of use and nonuse values that were associated with surface water improvements (their Appendix A). Of those shown, only three address both changes in fish populations and non-use values associated with them (Huang, et al. 1997; Whitehead and Groothuis, 1992; Olsen, et al. 1991).

We propose considering these three studies in addition to doing a review of the recent literature. The recent literature may be important because EPA has placed some emphasis on this ecological valuation recently. For example, there is a meeting entitled “Improving the Valuation of Ecological Benefits, a STAR Progress Review Workshop” that was held in Washington in October, 2004. The papers presented at that workshop are now available on the internet. One of them is directly related to California.

The results of this activity would likely be the development of a relationship (specifically a ratio) between use values and non-use values. For years, EPA used the 50% rule, a practice that implied that nonuse values were 50% of use values. Our approach, just like some of their 316(b) efforts (Tudor 2003), would be to refine this ratio for situations more akin to the changes associated with power plant operations.

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